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Creation and Maintenance of Installed Base in Service Business

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ABSTRACT OF THE MASTER'S THESIS

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Over the past twenty years a dramatic economic shift from goods to services has occurred. Companies have been interested in seeking additional revenues by offering after-sales services to their customers. This thesis shows why it is important to have clear understanding of what has been sold to a customer, i.e. to have a competent installed base. Furthermore, this thesis shows how to keep that information valid and how to utilize it in after-sales business.

The study was conducted for a company that manufactures weather systems and devices for environmental and industrial measurement. The company also offers its customers product-related after-sales services. The empirical analysis of this thesis consists of two individual sub-projects.

The first part focuses on the creation of installed base for products that have a system structure. The investigation will assess: which part of the organization is responsible for creating the system structures, update current process and train organization teams in question. The latter study focuses on the maintenance of an existing installed base. When the product is manufactured and delivered to the customer, it becomes Service's responsibility. This thesis answers the question which functionalities in Services participate updating and maintaining the installed base.

The research’s main objective was to better comprehend the reasons behind maintaining installed base information, to understand installed base information for system structures and their creation process in case company. Processes for both current methods were updated as well as suggestions for improvements were made to individual steps to ease the current process

Keywords: Installed base, Service, System structure, Maintenance, After-sales

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Viimeisten kahdenkymmenen vuoden aikana on tapahtunut dramaattinen taloudellinen muutos tuotteista palveluihin. Yritykset ovat pyrkineet kasvattamaan liikevaihtoaan tarjoamalla enemmän palveluita asiakkailleen. Tämä tutkimus osoittaa, miksi on tärkeää saada selkeä käsitys siitä, mitä on myyty asiakkaalle, eli mikä on yrityksen asennuskanta. Tämän lisäksi osoitetaan miten taataan, että asennuskanta-tieto pysyy validina, ja miten tätä tietoa voidaan hyödyntää myynninjälkeisessä liiketoiminnassa.

Diplomityön empiirinen tutkimusosuus muodostuu kahdesta erillisestä osakokonaisuudesta. Tutkimus tehtiin yrityksessä, joka valmistaa sääjärjestelmiä sekä laitteita ympäristön- ja olosuhdemittauksiin sekä teollisuuden mittaustarpeisiin. Yritys tarjoaa asiakkailleen myös tuotteisiin liittyviä myynninjälkeisiä palveluita.

Ensimmäisessä osassa keskitytään asennuskannan luomiseen suurempien järjestelmien osalta, joilla on systeemirakenne. Tutkimuksessa selvitetään mikä osa organisaatiosta on vastuussa systeemirakenteiden luomisesta, päivitetään nykyinen toimintaprosessi sekä ohjeistetaan ja koulutetaan nämä organisaation osat. Jälkimmäinen tutkimus keskittyy luodun asennuskannan ylläpitoon. Kun laite tai järjestelmä on valmistettu ja toimitettu asiakkaalle, siirtyy vastuu sen ylläpidosta Service-organisaatio:lle. Tässä työssä vastataan kysymykseen mitkä Service:n eri osastot käyttävät asennuskantaa ja mitkä eri osastot osallistuvat sen ylläpitoon ja päivittämiseen.

Tutkimuksen päätavoitteena oli parantaa ymmärrystä asennuskanta-tiedon ylläpidon menetelmistä sekä tärkeydestä. Sen lisäksi ymmärtää asennuskanta-tiedon rakenne ja sen luominen kohdeyrityksessä. Molempien prosessien osalta tämän hetkinen tomitusketju päivitettiin sekä yksittäisiä parannusehdotuksia tehtiin ketjun sujuvamman toiminnan takaamiseksi.

Keywords: Asennuskanta, Ylläpito, Systeemirakenne, Palveluliiketoiminta

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Contents

Abbreviations and definitions of focal concepts

ATO	Assemble to Order - A business production strategy where products ordered by customers are produced quickly and are customizable to a certain extent.
DES	Depot Service
DEV	Development
ERP	Enterprise Resource Planning - Integration of internal and external management information across an entire organization, embracing finance/accounting, manufacturing, sales and service, customer relationship management, etc.
EBS	E-Business Suite - Collection of enterprise resource planning (ERP), customer relationship management (CRM), and supply-chain management (SCM) computer applications.
FIS	Field Service
ISB	Installed Base - Set of individual pieces of equipment currently in use.
IP	Intellectual Property - Inventions, literary and artistic works, and symbols, names, images, and designs used in commerce.
PES	Performance Service
SO	Sales Order - Order issued by a business to a customer. A sales order may be for products and/or services
SR	Service Request - Request for a change, usually both common and straightforward, to be made to a service.
Z-item	System-item - Virtual system-item, top level for items that assemble a system in ISB.
TES	Technical Support

1 Introduction

This Master's thesis focuses on the creation and maintenance of a valid installed base (ISB). This thesis has been done for Vaisala's after-sales service department. Among other products the company sells large systems consisting of multiple sub-products, items and software to its customers. Thus, it is vital to have a clear understanding what kind of system has been sold and how the system structure is constructed. Furthermore, as important as creating a valid installed base is to maintain it properly. After sales functions benefit greatly from maintaining installed base, in form of various service tasks. Also, other functions in company can utilize a valid ISB such as sales, marketing and Product and Technology (PTE).

The main objective of this work is to create a common understanding of current processes, point out situations where ISB information is lost or false, create new work methods and then to implement new procedures as a part of whole supply chain. This is done for both the creation of ISB information and to its ongoing maintenance.

1.1 Background and Motivation

Over the past twenty years the major industrialized economies, especially in USA and in Europe, experienced a dramatic economic shift from goods to services and have been interested in seeking additional revenues by offering after-sales services to their customers. Services enrich the product portfolio and can, if bundled intelligently, offer immense leverage to enter and grow saturated markets. Service is a critical success factor for customer retention and market growth. [1] As shown (Figure 1, top), the U.S. economy reached the tipping point in 1987 when goods and services accounted for equal proportions of the economy. Since that time services have steadily increased [2].

The service sector is vital to Europe’s economy. Three quarters of Europe’s gross domestic product and more than three quarters of its jobs are generated by providing services. Worldwide 40% of all jobs are in services, compared with 38.7% in agriculture and 21.3% in manufacturing [3]. General Electric increased its service share of its medical products revenue to more than 40%. Rolls Royce increased the service share of its aerospace revenues to more than 50% over the past decade. [4]

Figure 1 (bottom) shows quality as the transformative business discipline of the goods-era. In the 1990s, business process re-engineering raised quality concepts above the factory floor and placed them in services contexts. Into the 2000s, innovation has become the transformative business discipline in the services-era. [2]

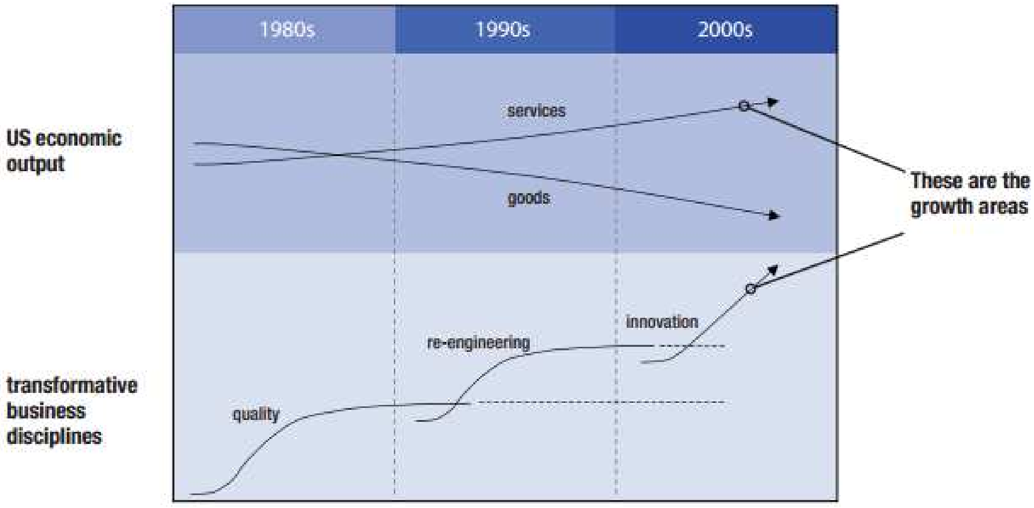


Figure 1: Transformative Business Disciplines. [2]

Three reasons have been identified for this shift of enterprise rationale. First, substantial and more stable revenue can be generated from an installed base of products with a long life cycle [5, 6, 7]. Second, the customers for capital goods demand more in services when concentrating on their core competences and seeking cost savings possibilities [8]. Third, services can be a sustainable source of competitive advantage [6, 9].

This shift to services challenges the role of traditional R&D, which involves having an idea, developing it into a technology and then applying it to underpin a product offering. In the service sector, an enabling technology needs to be coupled with a much closer understanding of customers, collaboration within the business to orchestrate the resources to deliver and sustain the service, and greater interaction with partners. [4]

Services are intangible - you can’t really examine a service before you use it. They’re simultaneous - services only exist at the moment of consumption, when both the supplier and consumer take a role in the success of the service delivery. They’re heterogeneous - it is difficult for a service owner to standardize the offering. Services are perishable - you can't stockpile services, e.g. tickets for a theatre performance. Worse still, services are difficult to protect through intellectual property (IP) tools such as patents - they are too easily adapted by competitors. [4]

As an aim to give customer the best possible service, it is vital to know what type of product the customer has and prior services delivered. To be able to keep track all the goods that company has sold to its customer an ISB needs to be generated. In ideal situation every business area/ part of organization takes part in gathering information and its systematical entry to database.

A capital goods manufacturer's business benefits from maintaining systematic records for individual products in their installed base. Installed base information can be essential for a company interested in improving both the value their customers get from using their products and their after-sales operations' profitability. [11]

At the same time after-sales operations' profitability can be improved through adjusting investments in service resources and service pricing based on the serviced products. Further, analyses of the installed products and the after-sales service operations support identifying performance problems with products, services, or customer contracts that decrease after-sales service profitability and require corrective actions. [11]

Whereas many companies are actively developing their installed base information management, apart from a few contributions, the currently available literature does not address installed base information as its own concept. Because the value and role of installed base information in after-sales service business is vital, this kind of study is eligible. [10]

Although companies have product-related records on their sales, production, deliveries, service contracts and service jobs, the data in the often function-specific information systems remains incompatible, and an overview of the installed base is missing. The resulting situation resembles that of manufacturing before Enterprise Resource Planning (ERP) systems were introduced to unify function-specific transaction data in the manufacturing process. Whereas the ERP systems for production have been powerful in standardizing transaction data involving product and component *types*, the value for customers after the sale is created through product *individuals*. To implement information systems focusing on individual products, it is necessary to understand which functions are interested in such information and what data should be standardized and gathered. [11]

1.2 Research Purpose

This research's principal aim is to support the development of installed base information management and to improve the business processes for both creation and maintenance of ISB information. The main goal is to find an efficient way of creating system structures in installed base within the case company. Research is done with the intention to suggest which function in organization should take this responsibility.

When considering the maintenance objective, the goal is to understand different service-lines processes and to update procedures to the extent of how ISB information is updated. Field services, Technical support and Depot services processes are evaluated and the situation where ISB information is read/updated is broken down to a more detailed level. Furthermore, other teams/persons that update ISB information are introduced and their roles clarified.

1.3 Thesis Structure and Research Approach

This thesis consists of 8 chapters. The first chapter after 'Background and information' is *Research context*, which covers literature review about installed base, Product life cycle and After-Sales Service Business. Third chapter is dedicated to an introduction of Vaisala, where the experimental part was performed. After that is the most important part of the thesis, 'Experimental part'. In this chapter a very detailed explanation is given how a valid installed base is created, especially for system structures, and which service-lines in after-sales services take part in ISB maintenance procedure. In addition, methods how these experiments were carried out are introduced.

The last four chapters are used to go through gained results and a discussion of topics related to results. In the chapter 'Results', numerical results are presented from pilot projects and workshops for creating system structures in ISB. After discussion, the chapter next to last is used to give suggestions to improve the current processes; mainly these are technical improvements in Enterprise Resource Planning (ERP) software. To bundle up this thesis, 'Conclusion' chapter is used.

Further, Appendix A shows all the A3 reports created alongside this project for understanding ISB, as a concept, in the case company. In addition, two separate A3s were made for both experimental studies.

2 Research Context & Literature Review

The purpose of this chapter is to introduce a few of the most common terms and concepts closely related to service business and installed base. This is done by literature review based on academic articles and scientific literature. Additionally, several interviews with Vaisala personnel were held to get a better understanding on the concepts dealt within this thesis.

Because the thesis is done for the company's after-sales service department, it is vital to understand what is meant by 'service' and what the main characteristics of after-sales are. Furthermore, product and product lifecycle are introduced, since service business is applicable during the products' entire life time. Additionally, installed base is explained as a concept, and also its importance and utilization for service business, e.g. from ISB it can be seen the lifetime and status of a customer's goods and indications if actions can be taken (up selling, upgrades, new software, etc).

2.1 After-Sales Service Business

2.1.1 Definition of Service

Service is a feeling and the experience resulting from the service rather than the actual process or the deliverables of the service. There are many definitions of service and sometimes services are difficult to identify because they are such a complicated phenomenon. The word has many meanings, ranging from personal service to service as a product or offering. Though several similar suggestions have been made, no ultimate definition has been agreed upon. [12]

Some definitions offered include, "Assistance of advice given to a customer during and after the sale of goods … an act of assistance" [13], "A service is a process consisting of a series of more or less intangible activities that normally, but not necessarily always, take place in interactions between the customer and service employees and/or physical resources or goods and/or systems of the service provider, which are provided as solution to customer problems." [15] Or " 'services' refers to those activities those capital investment goods manufacturers provide to support and improve the products they sell to their customers". [11]

Based on various opinions, a summarized definition for 'service' has been made as follows. Service is a compilation of different fundamental components and objects. In most cases the literature agrees that the core components and features of service are:

1. Services are processes - consisting of a chain of tasks or activities that provide an end result for a customer
2. Services are physically intangible
3. Services are produced and consumed simultaneously
4. The customer participates as a co-producer in the service production and evaluates the outcomes and the delivery of the service against their expectations [14]

Statement number two is partially incorrect as services can include both tangible and intangible components [16]. Therefore many services produce tangible outcomes or require tangibles, facilitating physical goods in the service process or contributing to products that are tangible or intangible. However, one should remember that it is the visible part of the service process that matters in the customer's mind [15].

There have been plausible arguments that the entire discussion about “what is product and what is service” is meaningless, as both can include tangible and intangible components [16], both require objectifying and stabilizing what is transacted between the provider and customer [17], and both require an understanding of the production process for efficient resource use in the production operations [18].

2.1.2 Service from Customer's Standpoint

As for the specific services manufacturers provide to their customers, there have been attempts to provide structure to the various service concepts based on whether they support the customer’s pre-sales or after-sales activities [19], whether they are transaction- or relationship-oriented [20], whether they support the products’ or customer’s processes [21], or what their strategic role is in the manufacturer’s business [22].

The chronological distinction of services concerning the sales process distinguishes among product services aiding the buyer in identifying the product offer and stimulating adoption (pre-sales services); product services aiding the customer in putting the product into use, such as installation and training (sales services); and product services keeping the customer satisfied with the purchase (Figure 2), such as failure handling and maintenance inspections (after-sales services) [19]. As the topic of this thesis indicates, the focus of this research is on the after-sales services where the existing installed base is the service target.

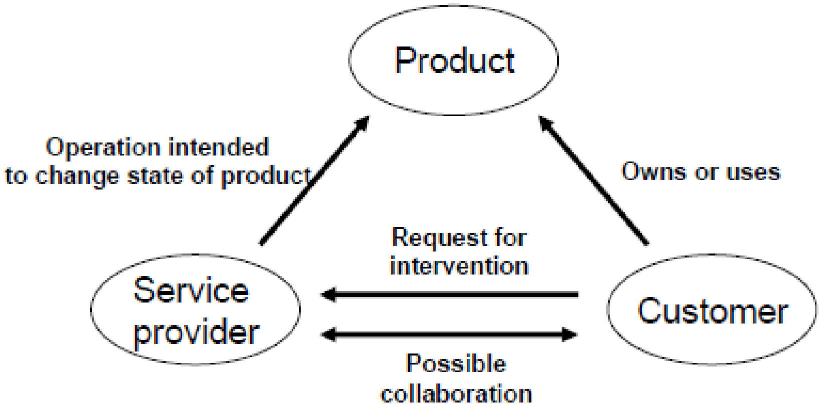


Figure 2: Responsibilities and functions between service provider, customer and product. [16]

Industrial services have been analyzed from the supplier's perspective regarding whether the services should be designed to support the customer's purchase and use of products as add-on service transactions or to strengthen the relationship between the provider and customer (Figure 2). [20] From the customer's perspective, service categorization is as follows: Does a service provide support for the product or, more directly, the customer’s business process. [21]

2.1.3 After-Sales Services

This chapter tries to answer the questions, "What are typical characteristics of after-sales service business? What are different types of after-sales services? And what determines which sort of after-sales business is feasible?"

To the extent a manufacturer’s resources and markets allow, selecting services to provide is a strategic decision [22]: If the role of services is perceived as unavoidable to handle warranties, the after-sales services are restricted to the lowest level of product support and the operations are considered a cost center. Or, the manufacturer might see the after-sales services as a source of revenues, for example, through spare-parts sales and consolidate the services as a profit centre. One step further, a relevant business generator can be identified by combining products and services into bundles, or solutions, that address the customers' needs on a larger scope. In such situations, the services are arranged as a business unit. Finally identify that, taking a long time horizon, the after-sales services can be perceived as a brand-fostering investment for excelling in product price, quality, and functionality. [22]

In a similar vein, it is considered that products and services form a system where customer value is generated through both product components and service components. [23] In the context of industrial services, their classification of what they call "product-service systems" can be reflected in maintenance outsourcing strategies from the customer viewpoint [24] which, in turn, are affected by different levels of asset management decisions [25]. A comparison of these three is presented below (table 1).

Table 1: Comparison of product-service systems, maintenance outsourcing contract types, and decisions influencing the contract.

Product-service systems [23]	**Maintenance outsourcing contracts** [24]	**Decision levels influencing the maintenance contract** [25]
Not a product-service system: Products and services considered separately.	*Work-package contracts*: maintenance planning and control performed by customer; service provider only provides staff and tools	*Operational control:* short-term allocations of maintenance capacity to maintenance demand. Decisions concern: maintain now or later, maintain or replace, use contractors or work overtime.
Product-oriented product-service systems: promoting/selling the product in a traditional manner, while including in the original act of sale additional services such as after-sales service to guarantee functionality and durability of the product owned by the customer.	*Performance contracts*: contract stipulates the desired performance on key outputs, such as failure rates, availability, response time, and time for restoring system interruption. Supplier can decide on necessary tasks to achieve those.	*Tactical control:* categorizing maintenance requirements based on equipment criticality and maintenance response urgency.
Use-oriented product-service systems: selling the use or availability of a product	*Facilitator contracts*: client is only the user of the physical assets owned and maintained by	*Strategic planning:* requirements for production units, estimating all cost factors

that is not owned by the customer (e.g. leasing, sharing).	contractors.	including maintenance during the life of the production unit.
Results-oriented product-service systems: selling a result or capability instead of a product	-	*Strategic planning*: company objectives and means to reach those objectives

Traditionally, products and services are considered separately. Products are the main sales item and product-related services are provided for those who ask for them. [23] From the customer's viewpoint such services from the product manufacturer are, by and large, only one alternative among others to source maintenance capacity [25]. Contracts matching such service supply and service demand can be seen as work-package contracts. With the product-oriented product-service systems, mentioned above, the supplied products and services have a common goal of uninterrupted operations for the customer. The customer retains the decisions on acceptable availability levels for equipment, negotiates a suitable performance contract with the supplier, and is indifferent about the exact maintenance plans and operations required to achieve the desired availability. [24]

With use-oriented product-service systems, the customer abandons equipment ownership and sources production capacity from the supplier if that is considered superior to investments in and maintenance of own production capacity. The agreement takes the form of a facilitator contract. Finally, with results-oriented product-service systems, the customer is considering a make-or-buy decision within its own production system. [24]

It is noteworthy that the product-service system categories can be seen to expand through the "basic installed base services," "maintenance services," and "operational services" [26]. Thus, such a particular development path towards closer supplier-customer relationships with each service offer level including and bundling the prior level's service offers [22] [23]. Put the other way around, if "basic installed base services" are considered components in providing the "maintenance services" and "operational services" from a service delivery perspective, the different product-service system strategies change the performance measures for the provider and responsibility sharing between customer and product service system supplier [22]. However, the field operations performed remains largely the same. Similarly, independent of the services offered, a key challenge for a capital goods manufacturer in the transformation to a product-service system supplier is the need to create a global service organization capable of responding locally to the installed base’s requirements. [26]

2.2 Product Life Cycle Management

In the literature Product lifecycle management (PLM) systems have been introduced to increase companies' productivity and efficiency to manage product data and to reduce the costs of product development. Usually PLM has been business concept for the goods manufacturing business. The growth of networking among companies and new business opportunities in after market service set up new challenges for companies. At present, the importance of PLM in an intangible business, such as service, has grown noticeably.

2.2.1 Definition of Product

The word 'product' has many meaning and implications within PLM. When talking about products, we usually mean physical product, goods that can be touched, owned, traded and distributed to different places at different times without changing their identity. Product does not only denote 'goods', it is more like a *benefit bunch* for which customer is willing to pay [28]. However, though word 'product' tends to give rise to an image of a product that can be touched, it can also be applied to intangibles such as services, software, knowledge or an algorithm project that can also be productized. Product can be defined in three different ways:

- Goods, meaning physical, tangible products.
- Services.
- Intangible products, which are not services, e.g. software.

Within product development, Product Data Management (PDM) and, more recently, Product Lifecycle Management systems are considered information systems that gather all relevant product information to be easily accessible through a uniform user interface [29]. Interestingly, product development seems to have scarce interest in the products they have designed after they have been delivered to customers. From the viewpoint of installed base information, the PDM/PLM systems consider “product data” as mainly related to product type (with possible revisions and/or variants), supplemented perhaps with manufacturing data on individual instances of the products [31]. Whereas this engineering and manufacturing data is seen as useful also in after-sales activities such as delivery, maintenance, and disposal [31], after-sales services are not discussed as a notable source of information in their own right. The only exceptions are short passing comments that product life cycle management also should cover the operations and maintenance phases [29].

Summing up, these contributions indicate that the role of information on the installed equipment seems more prominent in supporting product development, especially when evaluating design decisions aiming to affect reliability or the product’s life-cycle cost. Although focusing only on the marketing and R&D integration, formal interchange of information has a higher effect with less innovative new product development projects, whereas collaboration–oriented integration supports innovative new product development [32]. This supports the above inference that information on the installed product base could be most useful for assessing product development goals related to reliability and cost, rather than innovative new features. [11]

2.2.2 PLM in After-Sales Service Business

All products and services have certain life cycles (Figure 3). The life cycle refers to the period from the product’s first launch into the market until its final withdrawal and it is split into phases. During this period significant changes are made in the way that the product is behaving into the market i.e. its reflection in respect of sales to the company that introduced it into the market. Since an increase in profits is the major goal of a company that introduces a product into a market, the product’s life cycle management is very important. Some companies use strategic planning and others follow the basic rules of the different life cycle phase that are analyzed later. The understanding of a product’s life cycle can help a company to understand and realize when it is time to introduce and withdraw a product from a market, its position in the market compared to competitors, and the product’s success or failure. For a company to fully understand the above and successfully manage a product’s life cycle, it needs to develop strategies and methodologies, some of which are discussed later on. [30]

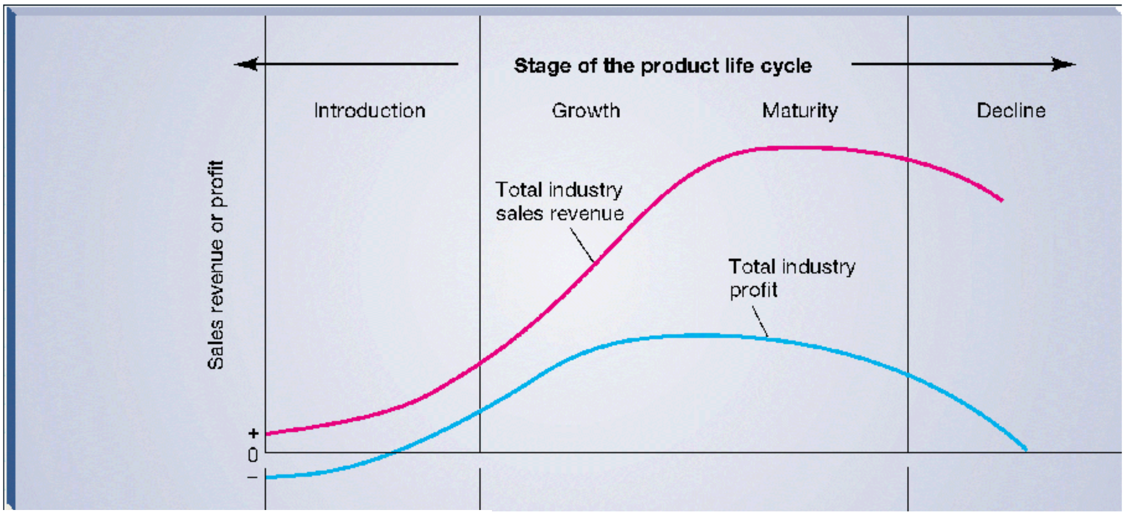


Figure 3: Product's life cycle graph.

The product's life cycle - period usually consists of five major steps or phases: Product development, Product introduction, Product growth, Product maturity and finally Product decline. These phases exist and are applicable to all products or services from a certain make of automobile to a multimillion-dollar lithography tool to a one-cent capacitor. These phases can be split up into smaller ones depending on the product and must be considered when a new product is to be introduced into a market since they dictate the product's sales performance. [12]

Product development phase begins when a company finds and develops a new product idea. This involves translating various pieces of information and incorporating them into a new product. A product is usually undergoing several changes involving a lot of money and time during development, before it is exposed to target customers via test markets. Those products that survive the test market are then introduced into a real marketplace and the introduction phase of the product begins. During the product development phase, sales are zero and revenues are negative. It is the time of spending with absolutely no return. [30]

The introduction phase of a product includes the product launch with its requirements to getting it launched in such a way so that it will have maximum impact at the moment of sale. This period can be described as a money sinkhole compared to the maturity phase of a product. Large expenditure on promotion and advertising is common and quick but costly service requirements are introduced. A successful product introduction phase may also result from actions taken by the company prior to the introduction of the product to the market. These actions are included in the formulation of the marketing strategy. [30]

The growth phase offers the satisfaction of seeing the product take-off in the marketplace. This is the appropriate timing to focus on increasing the market share. If the product has been introduced first into the market, (introduction into a “virgin” 1 market or into an existing market) then it is in a position to gain market share relatively easily. A new growing market alerts the competition’s attention. The company must show all the products offerings and try to differentiate them from the competitors' offerings. A frequent modification process of the product is an effective policy to discourage competitors from gaining market share by copying or offering similar products.[30]

Promotion and advertising continues but to the extent that was in the introductory phase. This period is the time to develop efficiencies and improve product availability and service. Cost efficiency, time-to-market, pricing and discount policy are major factors in gaining customer confidence. [14]

The maturity phase arrives when the market becomes saturated with variations of the basic product and all competitors are represented in terms of an alternative product. In this phase market share growth is at the expense of someone else’s business rather than the growth of the market itself. This time is the period of the highest returns from the product. A company that has achieved its market share goal enjoys the most profitable period while a company that falls behind its market share goal must reconsider its marketing positioning into the marketplace. [30]

During this period new brands are introduced even when they compete with the company’s existing product and model changes are more frequent (product, brand, and model). This is the time to extend the product’s life. [14]

The decline phase finishes product's life cycle. The decision for withdrawing a product from the market seems to be a complex task and there a lot of issues to be resolved before with the decision to withdrawn it from the market. Dilemmas such as maintenance, spare part availability and service competitions reaction in filling the market gap are some issues that increase the complexity of the decision process to withdraw a product from the market. Often companies retain a high price policy for the declining products that increase the profit margin and gradually discourage the “few” loyal remaining customers from buying it. [30]

Sometimes it is difficult for a company to conceptualize the decline signals of a product. Usually a product decline is accompanied with a decline of market sales. [12]

2.3 Definition of Installed Base

In service business, there is a need for a way to track the customer's installed base. It is also important to know what else is installed so it is possible to predict the behavior of products in that environment. Because this thesis aims to develop and improve ISB information management and its utilization in after-sales service business, it is necessary to provide a definition to the term *Installed Base.*

To start with, the term “installed base” is often used to denote an aggregate, ‘the total number of products currently under use’ or ‘a measure of the number of units of a particular type of product or system (in case of bundled offerings) actually in use’[26]. Whereas this is sufficient when evaluating market size or when comparing market shares of competitive products, exploiting business opportunities in the installed base requires a more detailed view of the products. [33]

Longman Business English dictionary defines installed base as "all the pieces of equipment of a particular kind that have been sold and are being used" [34]. When compared to *market share*, which reflects sales over a particular period, ISB can be seen as more reliable indicator for evaluating market size. Because ISB is not the same as the total number of units sold, as some of those products will typically be out of use, have gone missing, are broken or have become obsolete. The literature research revealed that the common definition for the term is the total number of units of particular type of system currently in use. Another definition given is, "A product's ISB is the total number of products currently in use". [26] The original equipment manufacturer (OEM) need not to be the organization which provides the after sales services. Because of that there is also the definition where the ISB is defined as the whole set of systems/products for which an organization provides after sales services. [10]

In discussing installed base systems as opposed to customer relationship management applications, following definition is used: ‘Installed base systems, attempt to track down exactly where the sold products are located, who owns and/or operates them, what they are used for, under which conditions they are applied, their life cycle status, which service actions and technical changes have been performed, which parts serviced or replaced and their current technical state.’ Along their definition of the installed base system, in the context of this thesis, the term *installed base* is used as a collective noun for currently used individual products sold or serviced by Vaisala. Thus, the installed base is regarded as formed by the individual products, rather than as a figure indicating the number of installations. Installed base information is used to refer to information on these individual products: their location, owner, user, application, operating environment, status, and service history. Consequently, installed base information management concerns the systematic gathering and storage of installed base information. [35]

From the system point of view, installed base is a multi-level structure of products and their components for managing and representing products at the customer site and products that are used internally [12]. ISB services encompass all product- and process-related services required by a customer over the product life cycle to obtain a desired functionality. [26]

2.4 Installed Base Information

The terms "data" and "information" are very similar, they are often confused in the world of database design. It is important to remember that data are the raw materials upon which a database is founded. After data has been processed it becomes information. [27]

The aim for this chapter is to provide an overview of the installed base information and define the different installed base information types. "Installed base information is used to refer to information on individual products." [11] In practice, this means information about products: location, owner, user, and application, operating environment, status and service history. The set of installed objects at the customer's can be used.;

- To determine the exact object for which a problem has been reported.
- To determine in detail what the transaction refers to. A case in point, repairs by field service.
- Information about object and which parts it consists of.
- For documenting changes made to objects.
- Direct use of installed base information in the context of individual service process with the customer.
- Statistics. [27]

Installed base information is divided into three main categories (Figure 4):

- Item data; information about products.
- Location data; customer's site or process phase that is the target of product deliveries or service operations.
- Event data; information about service operations. [12]

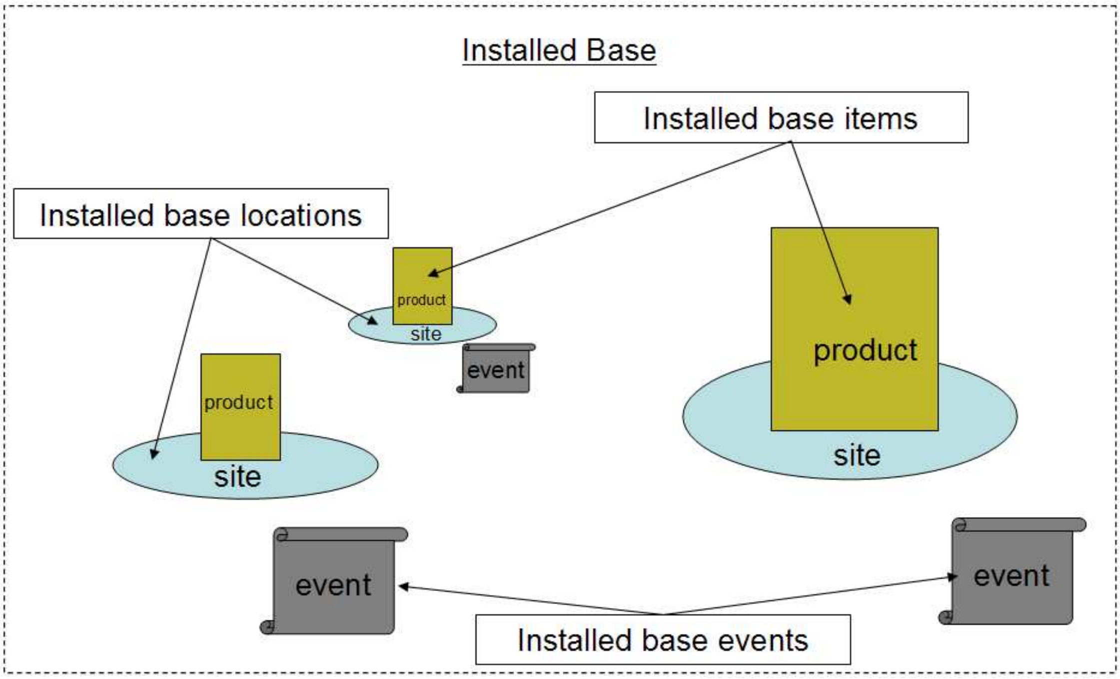


Figure 4: Installed base items, locations and events.

2.4.1 Item Data

Item data, which is also known as Equipment data, includes specific data which are needed to define each equipment item uniquely in the installed base management system. General equipment data included manufacturer, model number and serial number. Additional helpful data includes warranty period and operational data. One should capture this basic item information for equipment. Item data, which describes an item in the installed base, can be divided into two subcategories; item properties and item status. Item properties describe the item an artifact. Item status describes the performance of its intended function. Below is listed few main types of item data: [11]

- Equipment data; indicates the manufacturer.
- Model; indicates the type or model of the equipment.
- Life cycle status; information about equipment's life cycle status. Reference to service task.
- Warranty; coverage and period of warranty.
- Operational condition; equipment's performance.
- Classification; product version.
- Serial or lot number; unique code to define item. [12]

2.4.2 Location Data

ISB location data identifies the information which is related to the place where the equipment is located. For the customer, the key interest is the installed base location data. As long as the expected output of the location is secured and the expected costs are not exceeded, the exact item in operation and details of the service performed at the locations are irrelevant to the customer. A location's specific information is also important when comparing the performance of products across customer applications to improve the competitiveness a new products and service offers. Usually the location data reveals only the whereabouts of the item. Below is listed few main types of location data: [11]

- Owner/user; customer reference, identification of the owner and user of the products.
- Application; purpose of the use.
- Accessibility; information, for field service access.
- Installation date

- Interfaces; compatibility information
- Physical location; information on the location whereabouts, such as latitude/longitude or elevation. [12]

2.4.3 Event Data

Installed base event data consists of information about service actions. Different event data types need not to be managed in a single system. Different event data can be handled in their own workflow systems. To ensure comprehensive and efficient utilization of service event information, the main point is that all types of events should be accessible with the same search keys. Below is listed few main types of item data: [11]

- Event classification; indicates the task.
- Time stamp; identifies the time of event.
- Event performer; indicates the people responsible for the task.
- Item changes; identifies the changes made in the installed base.
- Event reason; root cause for the event's occurrence. [12]

2.5 Installed Base Information Management

The term 'installed base information management' describes systematic management, collection and storage of installed base information [11]. ISB information management is a tool or method designed for different service businesses to manage all kinds of ISB information. In general, ISB management is the product structure, i.e. ISB structure with its components and general data for the installed base or the components that are managed. The ISB contains only service relevant information. The installed base structure or functional location is a multi-level and hierarchical representation of a technical system which consists of components. The aim of creating a functional location is to structure a technical system or building into parts that are relevant for service actions. [12]

Even though, literature about ISB information is very limited and sparse, installed base information does not differ that much from Product data management (PDM); only the data is different. PDM system focuses on the management of technical data produced by engineering while ISB management concentrates on managing the lifecycle information which accumulates during the after-sales phase and keeps the ISB information up-to-date. [12] For this thesis' purposes two main areas of ISB information management are taken into closer examination; Item management and Product structure management. Other areas are: document management and change management.

2.5.1 Item Management

An installed base system is based on items and product structures. Item management is one of the most important processes, which must be in good condition before a company can implement the installed base system. An item is a systematic and standard way of identifying, coding and naming a model of physical product, part, document, component, material of service. Standardized items simplify the use and management of a products' related process. When discussing "items" in this thesis, an item is a single part of the product and cannot be divided into other items. An assembly of parts is a component and an assembled component creates a product. From the installed base management point of view, the "item" can be any independent individual with an identity [31]

Each item must have an identifier which determines the item. This identifier is usually called a code (such as a material number, item number, Serial number, etc.) The identification code can be a classifying or non-classifying code. A classifying code includes information on the item's characteristic and status information of the company's classification system. A classifying code has one problem: if the item information changes, the code will still remain the same and then the classifying code is outdated. [31]

A non-classifying code is an arbitrary character or number string and can be based, for example, on running numbering. In this case, all relevant classifying information is shown in attributes. Attributes describe what the item is like; description, item type, material information, status are all attributes. Because the item code (non-classifying) does not depend on the item characteristics, all attributes can be freely changed. The item can have several attributes (see chapter 4.2). Typically the item has at least a short unique identity code and a longer informational description. Item description should be logical so as to enable different users to understand the nature of the item. It would be advisable to use standardized terminology to describe the item, making it easier to find items later more efficiently. [31]

When the item is modified so that the new version replaces the old version, a new revision of item will be created. The new revision can replace all old revisions for the same item, but the old revision cannot be used in place of the new revision. The new revision's form, functionality and compatibility should be equal when compared to the old revision. It is necessary to check the following when considering a new revision. [31]

- What documents and items are affected by the change?
- What consequences are caused by the change in the sales unit(open offers sales material) production unit, purchase unit(open orders) and after-sales unit(delivered products)?
- What are the costs of the change?

2.5.2 Product Structure Management

Products often have hierarchical and multi-level product structures. Product structure is a decomposition of products which shows the material, component parts, subassemblies and other items in a hierarchical structure. The product structure forms the foundation of the installed base system, and the system is usually based on the use of the product structures and the items connected with it. The products and assemblies in the ISB system are created by attaching items, components, and documents to each other through the product structure.

The same product structure can be examined from different viewpoints. Typically a product structure is viewed from manufacturing or engineering viewpoints. Maintenance of several different product structures can become difficult in practice because the management and updating of relations between the separate product structures is such a huge task in complex products. [14 and Immonen] pointed out that the importance of recording and the maintenance of individual structures will increase continuously. When the demand for after-sales service and other product life cycle services increase and develop, maintenance and service companies will need to access the complete product information quickly in order to produce after-sales service efficiently. "In this context, we often speak of the installed product base, where the information about the owner and the current location of the product is attached to the individual product information." [14]

The management and maintenance of product structures are among the most important functions of the whole PLM or installed base system. Properties of version management, structural management, and configuration management are typically based on product structure management. The product structure must form a suitable and sufficiently exact description of each installed product in each situation; it is not always viable to store all product-related information for individual products in the PLM or installed base system. Information on a complex product, which consists of thousands of components, should not be maintained at too exact level. A suitable level of precision should be defined beforehand. Usually the product structure consists of functional modules, individual parts or subsections, and assemblies. An essential part of the management and functionality of the product structure is the different printable reports, such as version or change history and the order of assemblies. The purpose of attribute information is to clarify the product structure and information in the normal data fields. There can be three kinds of attribute information:

- Individual product-based information - such as unique serial number
- Generic product information
- User-specific information - remarks and notes. [14]

2.6 Installed Base Utilization

2.6.1 Business Goals and Benefit of Implementation of ISB

There are several possible business goals and objectives which can be achieved through the successful implementation of an ISB. Furthermore, faster resolution of customer problems when the exact environment of a problem is known, which improves customer satisfaction

- Increased potential for revenue, because the potential up sell and cross-sell potential of products and services due to improved knowledge of the environment at the customer site.
- Better quality and accuracy of customer service.'
- Faster access to relevant information.
- Reduced error rates. [12]

2.6.2 ISB Remarks

Extant literature on the function-specific information requirements reveals that there indeed can be installed base-related uncertainties in the subunits of the organization, (i.e. available information is less than required information) [36]. Moreover, the information requirements seem uniform enough to warrant a high-level conceptualization of “installed base information” as a phenomenon of its own. In addition, this concept only indirectly addressed this far motivates further inquiries into systematic installed base information management.

In addition to the Service information requirements, the context of the original equipment manufacturer as the service provider needs to be considered. The most often cited installed base information users outside service operations are related to product development [22] and sales and marketing [37]

2.6.3 Other Operations that Benefit from ISB

Sales and marketing have the firsthand responsibility to generate revenues for the company, but also doing it in a beneficial way by striving for continuity and profitability in the customer relationships [38]. This entails the use of customer information, including product and service usage, to identify priority customers for specialized treatment and to segment others for more standardized approaches. Product development aims to develop lucrative new offers thriving on novel features and on improvements of known sources of dissatisfaction [39]. The latter, in particular, have been noted to benefit from reviewing existing products and their performance in the customer applications [40].

2.7 Literature Recap

The literature review was done to get better understanding what is meant by 'product', 'service'. Table below collects the main differences between product and service, as they are presented for this thesis' purposes (table 2). Furthermore, product life cycle management was introduced as a concept, because it plays vital role along the product's lifetime, and is essential tool for after-sales business. Finally, and most importantly, the term *'installed base'* was introduced.

In case of ISB more thorough clarification was done in order to see how ISB can drive business and what the greatest benefits from well functioning ISB are. Also, how ISB base affects after-sales business, and what kind of information is valid to gather for ISB use. Additionally, after-sales service business was introduced as a concept and also what defines what kind of after-sales business can be performed.

Table 2. Main characteristics between 'product' and 'service'.

Characteristic	**Manufacturing**	**Service**
Nature of location		
Number of location	Few	Many
Placement of locations	Near key resources	Near Customer
Nature of employee		
Skill type	Technical	Behavioral
Nature of customer		
involvement	Little	Great
Physical contact	Low	High
Customer participation		
Nature of deliverable		
Perishable	No	Likely
Tangible	Yes	Mostly intangible
Constraining resources	Equipment, Materials	Labor
Nature of capital structure		
Fixed costs	High	Low
Variable costs	Low	High

3 Case Company

3.1 Introduction to Company

Vaisala is a Finnish company that develops, manufactures and markets products and services for environmental and industrial measurement [43]. Two business areas conduct business: Weather and Controlled Environment. Weather-business customers are the meteorological facilities, airports, roads and railways, defense forces and the energy industry. Controlled Environment business offers products and services to life science customers and many applications in various industries. The business areas are supported by the group wide functions: Products and Technology, Services and Operations [44]. Vaisala's operations began in 1936 when the company's founder, Professor Vilho Väisälä began the production of radiosonde that he had developed. [43]

Vaisala's own sales and services forceare presented in 15 countries, company serves customers in over 150 countries annually. [44] In 2011 Vaisala achieved net sales of 273.6 million euros and operating profit of 16,1 million. Operations outside Finland accounted for 98% of net sales. [42]

3.1.1 Installed Base History

Vaisala has long history of being product oriented company. Growth has been based on acquisitions and finding new markets. New customers are typically more difficult and costly to get than keeping existing ones. ISB has not been significant driver for business. Furthermore, Vaisala has required ISB information mainly to run service operations. Additionally instrument sales have utilized ISB information to clarify market situation. However, valid installed base and effective utilization of the information is one of the most important tools to gain more revenue within current customer base. Valid ISB information is also needed for guaranteeing service operations to run effectively.

Since 1995 all Vaisala delivered products have been documented to create ISB. Beginning of 21st century an ISB development project was conducted to create and maintain useful installed user base with valid information [41]. Also, system structures were created for few larger assemblies.

After project was carried out, Vaisala ISB has continued to grow in multiple separated databases. Mostly because of various organizations in Vaisala have used ISB differently based on local requirements and best practices. Because of the unclear global practices and responsibilities the data in ISB has decayed over the years. Furthermore, ISB has had no owner. So, no one is responsible for the correct creation and maintenance of the ISB.

Implementation of new ERP system (in May 2010) did not include conversion of old ISB data to the new ERP system. Common understanding of ISB architecture (parameters / attributes) does NOT exist. In general ISB is not considered as reliable data source.

3.1.2 Present State

In 2010 Vaisala transferred to new Electronic Resource Planning (ERP) tool. Before that, there had been several ERPs based on geographical location, which then resulted in several different ERPs and also dissenting installed bases. Legacy systems have different architecture in multiple sources, depending on the product area.

Legacy systems and some specific instruments are more valuable to be available through future ISB system than rest of the legacy data. ISB items older than 15 years do not have any significance for service operations or business decisions. Functioning ISB system is necessity while transferring to more service oriented business, because significant part of service business is generated through existing installed base.

Within 10 years problem related to legacy ISB will be solved automatically, because old data will then be irrelevant. Estimated additional costs for 10 years operation without legacy ISB is about *10 man-years (1 MEUR). Added with the lost up-selling business potential (e.g. 1% increase of ISB units returning to repair/calibration = 5MEUR /annually).

Vaisala uses Electronic Business Suite (EBS), collection of enterprise resource planning (ERP), customer relationship management (CRM), and supply-chain management (SCM) computer applications, to run its business

All products delivered though EBS system are automatically stored to ISB. However, most of systems delivered through EBS do not have proper system structures in place. This creates situation where it is impossible to separate individual products from larger systems. Systems are key drivers for service contract related business, and service business altogether. Vaisala delivers more than 300 systems annually.

3.2 Vaisala's Installed Base

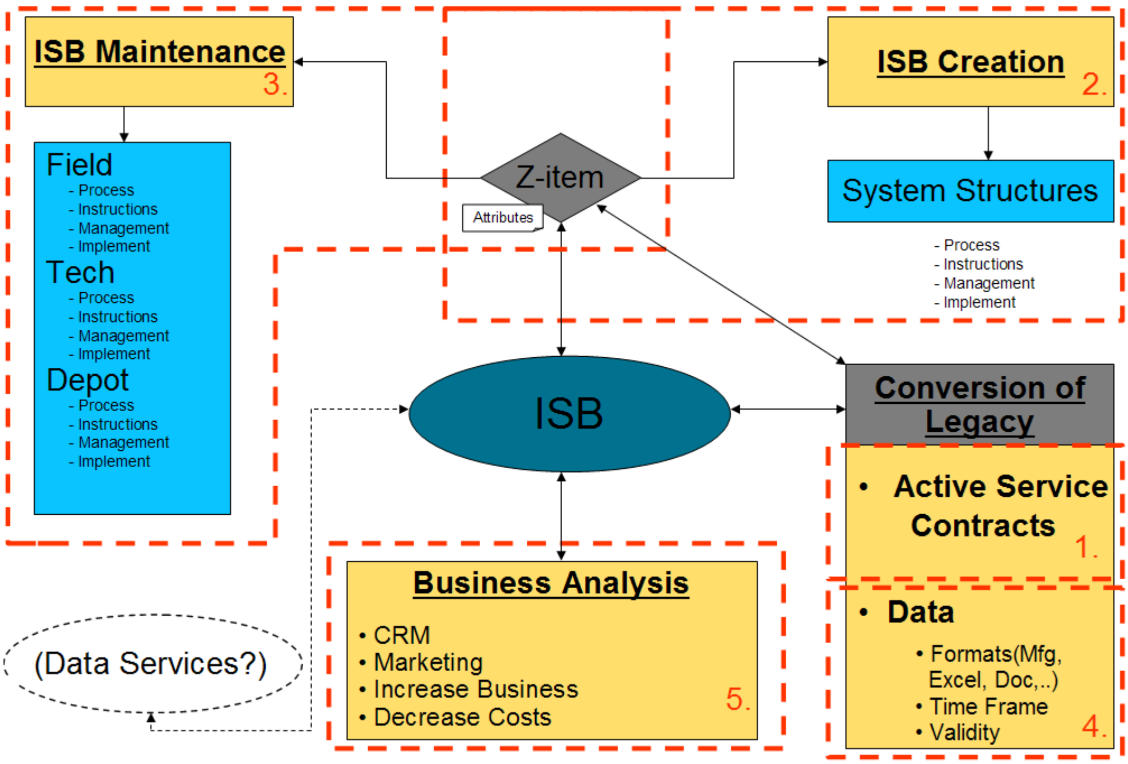


Figure 5: Project scope. Red dash line boxes represent different sub-project inside Installed base project.

Above figure shows all the functionalities that are related with installed base (Figure 5). Box number 1 presents all service contracts that have been sold to a customer. Because service contracts form large part of Services revenue, it is vital to have all the contracts, and contract related information, such as service tasks and products, in ISB.

Boxes number 2 and 3 are closely related system-items (Z-items). Z-item is needed to be able to have functionally system structure in ISB (See chapter 4). 'Attributes', linked to z-item are parameters used to give more specific understanding on each used z-item (See chapter 4). Sub-project number 2 is associated with system structure creation process. Sub-project 3 concentrates on ISB maintenance for different service-lines (Field- , Tech Support- and Depot Services).

Conversion of legacy data (box 4) means all products and services sold to a customer prior new Electronic Resource Planning was adopted in Vaisala (See chapter 3.2.1). Especially for after-sales services, to be able to gather ISB information from as long as possible, is essential. Customers might need service for purchases made more than 10 years ago.

Business analysis considers all the numbers related to ISB, and to what it might affect. What type of up-selling can me made based on knowledge from ISB, or how much more efficient specific service-line could be with ISB information available. Data Services, where company provides only the data to the customer, are marked with dashed line, because at the moment this kind of information is not ISB tracked. This thesis concentrates on scopes number 2&3, creation of ISB and maintenance of ISB (See chapter 4).

3.2.1 Desired ISB Status

Installed base affects many different functions in organization, which means that valid information is nearly essential. Unsure ISB information prohibits fluent processes, especially for Services. Furthermore, all upgrades and improvements are impossible without reliable ISB, such as up-selling or information usage for marketing purposes.

Without ISB information each service activity would require on average excess work of 5 minutes for additional work to gain necessary information / activity. This would then eventually result in total excess work of 2 man-years /annually.

ISB information is needed for (Based on 2011 numbers):

- 30 000 depot operations per year
- 500 site visits per year
- 18 000 tech support cases annually
- 1000 active service contracts

Valid ISB would enable:

- Fluent handling of service contract related activities, which would then result in; work hour savings for average of 3 man months annually (0,5 hour / contract / year).
- Technical support would be able to response faster to technical support queries, when all needed information is available. Less explaining/emails needed in order to receive needed support. On top of that, work hour savings for 1 man-year /annually (10 min/ 10 000 case).
- For depot services valid ISB would result in lower throughput times.
- Lower system downtime.
- Traceable original set up/configuration for disaster recovery. 1 man-month annually (100 cases /2h per case).
- Efficient field operations. Such as, decreased number of revisits and unplanned site days. Also, work hour savings for 2 man-months site visit preparation time (500 visits / 45 min).
- Improved customer satisfaction.
- New ISB based service offering.
- Proactive sales and marketing though valid ISB data (*5MEUR only for repair/calibration business*).
- Service according to contract.
- Clear item history for decision making.

3.2.2 Installed Base Architecture & Hierarchy

Like mentioned above, service contracts are one of biggest business areas for after-sales business. ISB architecture enables linking service contracts to different levels ISB structure, i.e. hierarchy (Figure 6). When service contract is linked to wanted target, for example 'Site', it automatically is linked to all sub-components (System and Product). This provides ways to link different types of contracts to same customer in a way that they touch different functions. A case in point, customer (party) can have a technical support via email, which means that all customer purchases have tech support. On the other hand, a preventive maintenance contract can be sold to a specific system or only a single product.

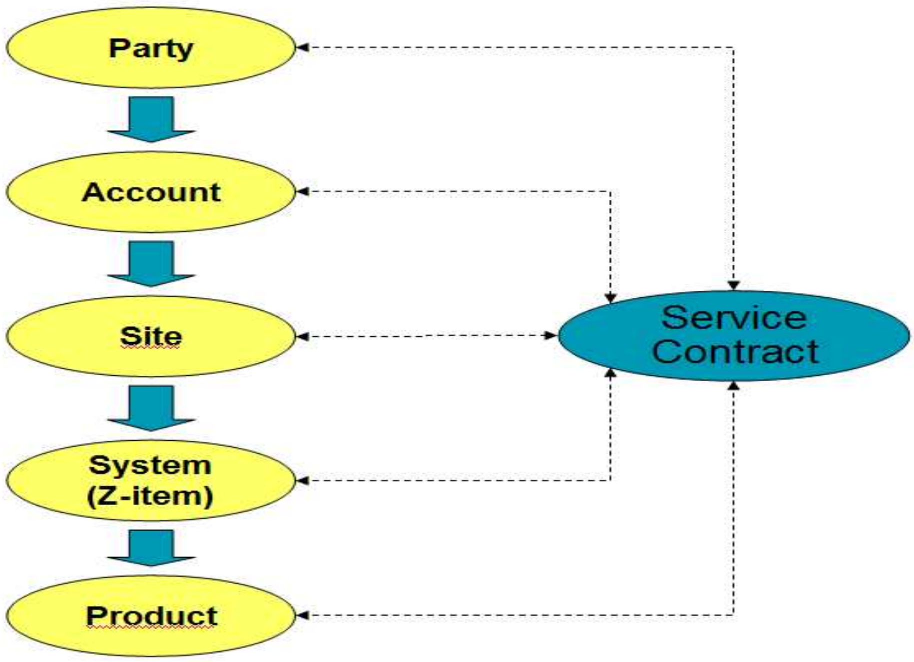


Figure 6: ISB hierarchy in eBS.

The up most level in ISB hierarchy is: 'Party'. This corresponds to customer. Under 'party' can be several different 'Account', which means various individual business areas that customer can have. Under 'Account' is 'Site/End user': The location (installation site) where the system is installed and operated. There may be several 'Sites' attached to one customer, for example multiple airports under one aviation customer. Next in line is 'System', which is used for the parent item that binds together all items that construct a system. The final level is 'Product': the separate items that can be sold separately or build up a larger system, as mentioned above.

4 Empirical Analysis

4.1 Background & Research Tools

Vaisala delivers several hundreds of systems per year, for which an average life time is 10 years. Systems can consist from numerous different items and create complex hierarchical structures. In situation, where customer has a service contract or needs other service performed for the system, information must be accessible and valid through whole lifetime of a system.

However, most of the company's systems have been productized in a way that the top level item is missing from system structure. This in order creates a situation where system structure is lost in ISB and it is impossible to manage systems, while they are mixed up with other items in ISB.

To avoid this kind of situation and to ensure valid ISB information, a research was carried out to determine how correct system structure could be achieved, and to maintain this created information in a way that information from installed base would always be valid. The research was divided into two individual sub-projects. First project concentrates on creating useful and valid installed base for system structures. The latter part deals with maintaining the created installed base, within the service department, and its utilization. Furthermore, different tools and procedure to carry through the experimental part are introduced. Such as A3 – project reporting tool, Workshop(s), pilot project.

Project was carried out by conducting several interviews, creating three separate A3 reports, organizing a workshop, and generating a pilot project for building system structures. Pilot project was also adjusted along the way to ensure, as efficient as possible, process.

This chapter is structured, as follows; methods and actions used for this experiment are firstly presented. Thereafter, the experimental parts are shown in separate chapters, and finally results are presented.

4.1.1 A3 Report

Total of three separate A3 reports were created. One for current situation of installed base in the company, and two, more detailed, A3's for 'creation of system structures' and one for 'maintenance of ISB', respectively(See Appendix A).

The A3 report is a tool that originated from Toyota Motor Corporation. A3 is used to propose solutions to problems, give status reports on ongoing projects, and report results of information gathering activity. The term "A3" derives from the paper size used for the report, which is the metric equivalent to 11" x 17" (or B-sized) paper. The thought behind A3 is that when you structure your problem solving around 1 page of paper, then your thinking is focused and structured. The A3 will systematically guide problem-solvers through a rigorous process, document the key outcomes of that process, and propose improvements. [45]

The report flows from top to bottom on the left-hand side, then top to bottom on right-hand side. The basic storyline on A3 remains more or less the same, even though the boxes or the names on the boxes can change. (Figure 7) [46]

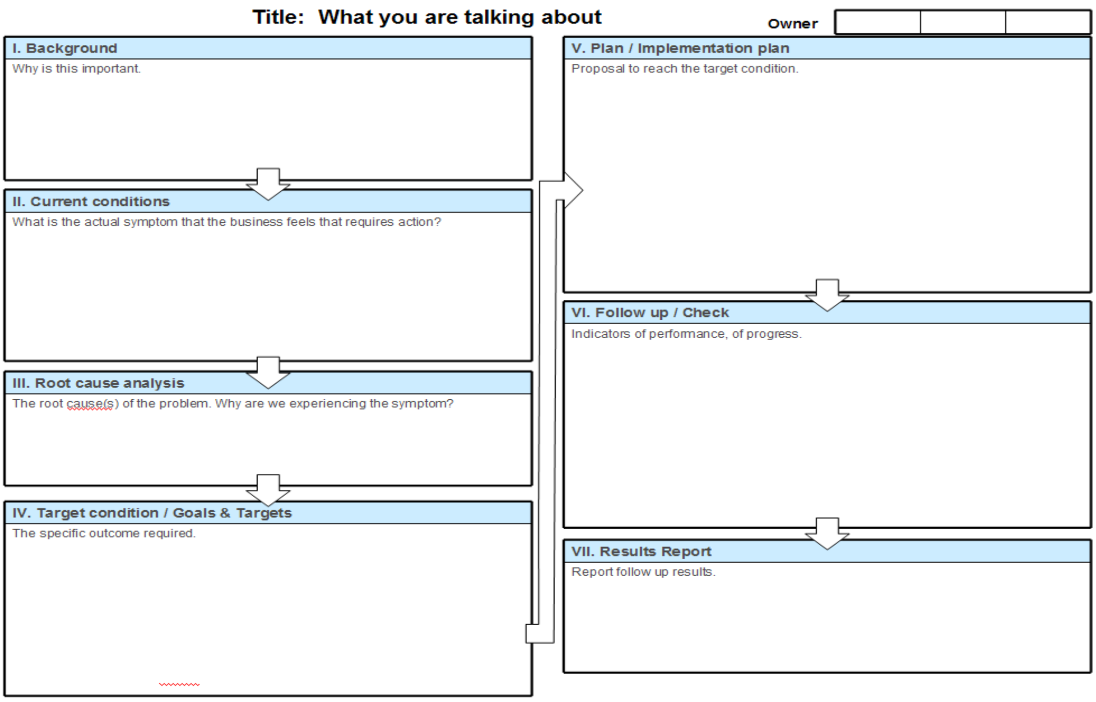


Figure 7: Default A3 report template

Every A3 report starts with a *title* or "theme". The title indicates the problem being addressed, and is quite descriptive. Title should also focus on the problem in hand, and not advocate a particular solution.

Next, the A3 report author describes relevant *background information* that is essential to understanding the extent and importance of the problem. Topics in this box could be for example; how the problem was discovered, why the problem is important to the organization's goals, problem symptoms, past performance or experience, organization structure, and so forth. [47]

Current condition is generally the most important section in A3. Here the author explains how the system, that produced the problem, currently works. Also, quantifying the extent of the problem should be made (e.g. percent defects, hours of downtime, etc.). In most cases it helps, when this information can be displayed graphically or numerically (diagrams, charts, etc.). The data used to develop *Current condition* box is collected through direct observation. In-depth and detailed understanding of the current process as it is actually performed, rather than how it should be done or how somebody says it is done, is absolutely critical. Stakeholders can usually describe how the process is suppose to work, but deviations from this general or hypothetical conception often hold the key to addressing the actual problem. Thus, the data describing the extent of problem should be actual data, not educated guesses.

The purposes of diagramming and quantifying the problem are several. First, the act of drawing a diagram enables deeper understanding by helping the author organize knowledge and learning gained from observation compactly. Second, the diagram quickly and effectively communicates the core issues to others. Thirdly, by diagramming the system, problem-solving efforts are focused on the system rather than the people. This results in a more objective approach. [47]

In *Root cause analysis* the author comes to understand the root cause of the problem symptoms shown in current condition diagram. Failing to address the deeply rooted seed of the problem means it will likely recur. Commonly the root cause deals with at least one of three basic principles for design of organizational systems: 1) Are work activities sufficiently specified according to content, sequence, timing, and outcome? 2) Are connections between entities clear, direct, and immediately comprehend? 3) Are the pathways along which products/services travel simple, direct, and uninterrupted; are all the steps value-added? In short, problem-solver should consider whether activities, connections or pathways are the root of the problem. [47]

Next in line is *Target condition*. Now the author has clear idea how the system currently operates and what are the root causes of the problems experienced. Consequently, improvements for the system could be considered. In A3 improvements are usually called *countermeasures* because it implies that a) a specific problem is countered, and b) it is used while even better countermeasure is discovered. The countermeasures address the root cause while conforming to the three design principles, mentioned above. The goal is to move the organization closer to an ideal state of providing exactly what the customer needs, efficiently, in precisely the right quantity, and without waste. The author can now create a diagram of how the envisioned system will work with the countermeasures in place.

The *Implementation plan* outlines the steps that must be accomplished in order to realize the target condition. The steps are listed, schedule is created when the steps need to be done, and who is responsible.

The Follow-up plan indicates how and when the improvements of the system or the results of a specific test are measured. This should include a realistic and quantified prediction of how the new system will perform (e.g. turnaround time reduced to X minutes, or Y% decrease in defects). The prediction should be as accurate as possible, based upon the understanding of the work and the countermeasures planned.

Finally, the *Results report* is created to report follow-up results. It is fairly extensive, including a list of shortcomings and plans to address them. The follow-up results reporting step is absolutely critical to maximize learning within the organization. [47]

The current condition and root cause constitute the necessary background research, the target condition and implementation plan outline the experimental design, and the follow-up plan states the hypothesis. So, the results reporting section is critically important for evaluating whether the hypothesis is supported. If so, understanding is confirmed and project has been successful. If not, present understanding is incorrect or insufficient, and additional background work is needed. [46]

Three different A3 reports were created regarding the thesis, one for overall scope of the project, and two, more detailed, A3 reports for sub-projects inside the theme. First A3 concentrates on the matter why this project was ever launched and why it is important for the company. A3's for sub-projects demonstrate the specific problems and the desired outcome. Also, the latter A3's have more technical solution suggestions and in-depth analysis for the challenges that the operating system has. All the A3's can be found on the appendix.

4.1.2 Interviews

Various interviews were made to gain, as thorough understanding about Vaisala's ISB current status, as possible. People from different fields of work and with different responsibilities were interviewed, such as; Database administrators, Field Service Engineers, Depot workers, Tech Support workers, Supervisors, etc.

First round of interviews concentrated on getting the overall picture of company's ISB current situation. How information has been gathered previously versus how it is done at the moment? What functionalities the previous ERP lacked/had? What are the pros and cons for transferring new ERP -system? What is the current status of information available in ISB? Is it easy to access, and is all the needed information in place?

Second and third round interviews were carried out with specified people to get more detailed picture about ISB creation and ISB maintenance.

Second round was concentrated on people who do the initial effort to enter data in EBS ISB, i.e. create the ISB information, and more specific, the data structure for systems. Different teams and functionalities in organization, that take part in system deliveries, were interviewed. This was done in order to understand the delivery chain for systems and projects within the company, and furthermore, to be able to suggest, for which teams the data entry process would be reasonable to implement.

Third round interviews were targeted to different service lines in part of ISB maintenance process. This was basically limited to Technical support, Depot Services and Field Services as they do the most of ISB updating. Both managers and technicians were interviewed, to understand the whole supply chain and to understand details in specific tasks performed everyday.

4.1.3 Workshops

A number of workshops were held with different teams in organization; Project Management Office (PMO) and Operations (OPS). These teams were obvious choices, because they both handle system and project deliveries. The main outcome that was needed from workshops was to understand the workload and also to measure time needed for creation process. The results gained, also limited the possibilities where this extra work could be directed. Based on the results and feedback gathered from workshops, a pilot project was launched to test updated process in practice.

4.1.4 Pilot Project

Pilot project was conducted for new systems that are delivered from the company. It was decided that pilot project should be carried out as cooperation between SER and OPS. Where OPS would provide all the vital information, since they are the ones handling the equipment, and SER personnel do the data entry in EBS ISB. Pilot project was launched in early June. Even though results gained were quite limited, a clear understanding of the process and its challenges could be derived.

4.2 Creation of System Structures

As mentioned in the beginning of this chapter, system structures are formed from separate sub-structures or items, which are not linked to each other. As an end result, current ISB structure does not show up as systems, only a list of items (Figure 8). This is due to EBS functionality and product design, where systems are configured under top item. This creates a situation where it is impossible to say how many/what type of/with what configuration system(s) is sold to a customer. Further, systems get mixed up with other products sold to a customer. Spare parts, individual instruments and systems are all in the same non-organized list.

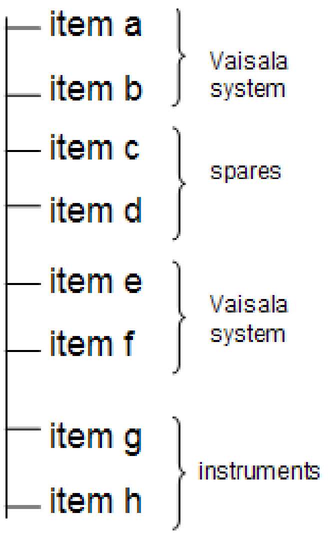


Figure 8: Current ISB view.

To solve this problem, a virtual system-item (z-item) that binds together system items, is created in EBS ISB. Constructing the structure is done after the delivery. This creates clear system structure into EBS ISB (Figure 9, right side). For this purpose, an assessment of company's current system delivery process was done through interviews and workshops mentioned in previous chapter. Also, time spent and workload for this process was measured.

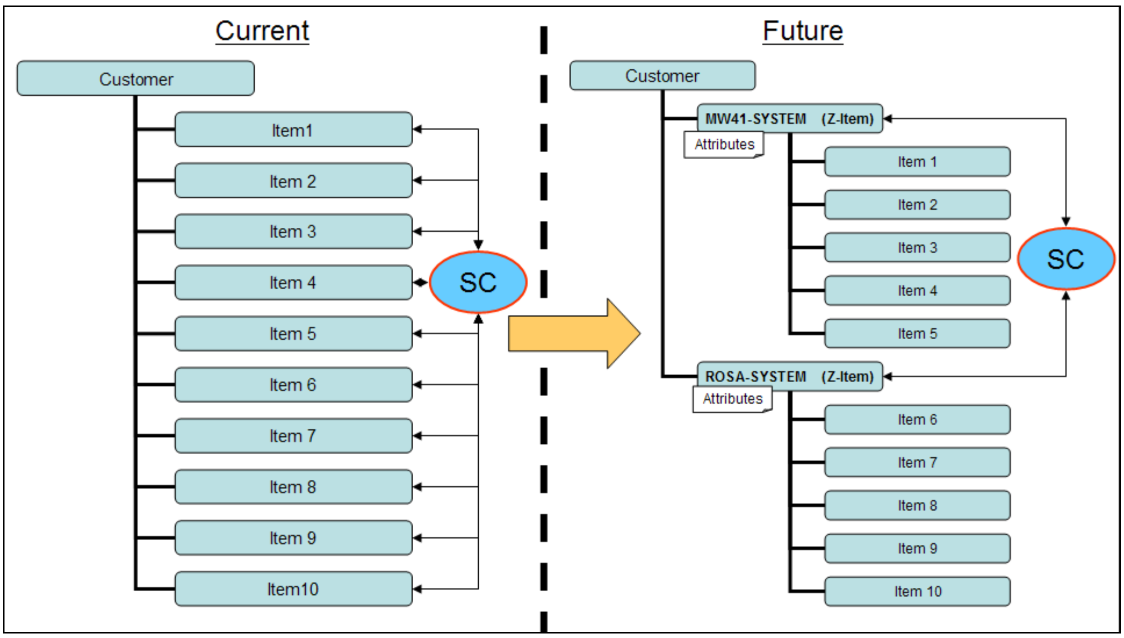


Figure 9: Current and future situation how the systems are seen in Installed Base.

Figure 9 (left side) shows how systems are currently seen in ISB and what the wanted situation (right side) is. Currently, as was mentioned, it is nearly impossible to know which items construct a system and which items are spare parts, instruments, etc. Also, linking a service contract for customer's products is a huge task, because each item has to be linked to service contract individually. In future situation, service contracts can be linked straight to system items (Figure 9, right side), where the contract is automatically linked to each item underneath system-item's structure.

⊟ Hide Additional Attributes

Name ▲	Value	Category
Altitude (Value & Unit)		LOCATION
BACNET (Device, Protocol)		TELEMETRY
Cellular (Type, Carrier, Number)		TELEMETRY
Configuration Code		
Configuration Comment		
Elevation (Value & Unit)		LOCATION
Ethernet (Type, IP Address)		TELEMETRY
Highway Location		LOCATION
ICAO Code		SYSTEM
Latitude (DDD MM.MMM)		LOCATION
Local Partner		LOCATION
Longitude (DDD MM.MMM)		LOCATION
Magnetic Declination (Deg)		LOCATION
Mains Type		SYSTEM
Mast Height (m)		SYSTEM
Modbus (Device, Protocol)		TELEMETRY
Phone/PSTN (Type, Carrier, Number)		TELEMETRY
Radio (Type, Freq)		TELEMETRY
Road Number		LOCATION
Satellite (Type, Provider)		TELEMETRY
Sensor Protocol (Type)		TELEMETRY
Service Provider		LOCATION
Site Name		SYSTEM
Station ID		SYSTEM
Vaisala Item Revision		
WMO Code		SYSTEM

Figure 10: System-item related attributes.

To be able to make ISB information, regarding systems, more efficient an attribute map of 23 fields was created (Figure 10). This attribute map was then linked to each system-item. Attributes come from three different categories, 'Location', 'System' and 'Telemetry'. These attributes were introduced to give extra information about customer's systems. They can be also used as search criteria. For example, to search all systems that have been sold to one specific site, or to see all systems that are operating in specific altitude. Entering attributes is suggested to be part of system structure creation process.

4.2.1 Current Challenges & Problems and Desired Outcome

Currents ISB architecture creates problems and challenges in Services, to perform efficiently their everyday tasks. For effective service operations system structures need to be visible. Also, for fact based business decisions it is needed to know how many and what kind of systems have been delivered, and where.

Technical support isn't able to support customers effectively due to lack of system structures. Technician is impossible to say what type of a system customer has and what devices/ features those system posses. Vaisala's personnel perform several thousand cases related to the systems per year. If data in ISB in invalid or totally missing, employee needs to devote more time to find information and this is always away for serving the customer. This affects directly to customer satisfaction and lead times.

With incorrect ISB, field service technician isn't able to prepare for site visits. Field services perform around 500 site visits per year. When ever the data used to prepare these site visits is false, a risk for re-visits is present, e.g. missing parts, wrong software or different location. Almost all project and service related travelling is due to systems.

The desired outcome from this effort would be that in future all systems are show up in ISB correctly, system structure and attributes in place. Furthermore, it is not the ideal situation that this kind "after delivery" performance is needed. Product designing is moving towards situation where systems go to ISB as systems not as list of items. Even though, this is not a long-term solution, the end result with "correctly" designed products, would in the end look the same as systems that have been constructed with virtual system-items.

4.2.2 Work Plan

Original plan was that system structures would be created in two different teams, who participate in the delivery of projects and systems; Project Management Office (PMO) and Operations (OPS) respectively. Majority (~90%) of systems, that the company sells, are handled as projects, which means that they need PMO's assistance. Rests of systems are delivered through Standard Shipping Factory (SSF), which indicates that only OPS are needed for the delivery process.

Based on complexity, systems are sold as projects or standard deliveries. For latter case Project Technician would create the needed structure in EBS ISB. Information for configuration comes from Sales Order (SO), which indicates which components construct a system. In situation where system is sold as a project, Project Assistant would build up the system structure in EBS ISB (Figure 11). Consequently, responsibility for starting the system structure creation process is on OPS or PMO. In both cases, entering the attributes is done as a part system creation process. In both, system and project deliveries, attribute information are provided by system expert. System expert is the person aware of all the parameters and details related to the system. Project Technician or Project Assistant enters the data based on the information given.

When the original structure has been created for the systems, ISB information responsibility moves to SER, (figure 11) to add missing information and make possible changes, e.g. malfunctioning part. Based on the system that is been sold, a final inspection test (FIT), Factory Acceptance Test (FAT), Site Acceptance Test (SAT) (as part of installation) or combination of these is made. As these actions are performed, it is SER personnel responsibility to supply missing data to EBS ISB. This can be several things: new gathered attributes, such as 'Station name', 'Elevation' or 'Latitude/Longitude'. New data can be site related, i.e. system is installed on different site that it says on EBS ISB. Or it can be modification on original system structure: new part is needed to replace broken one, or new product need to be installed in order to system to function properly, e.g. different cable.

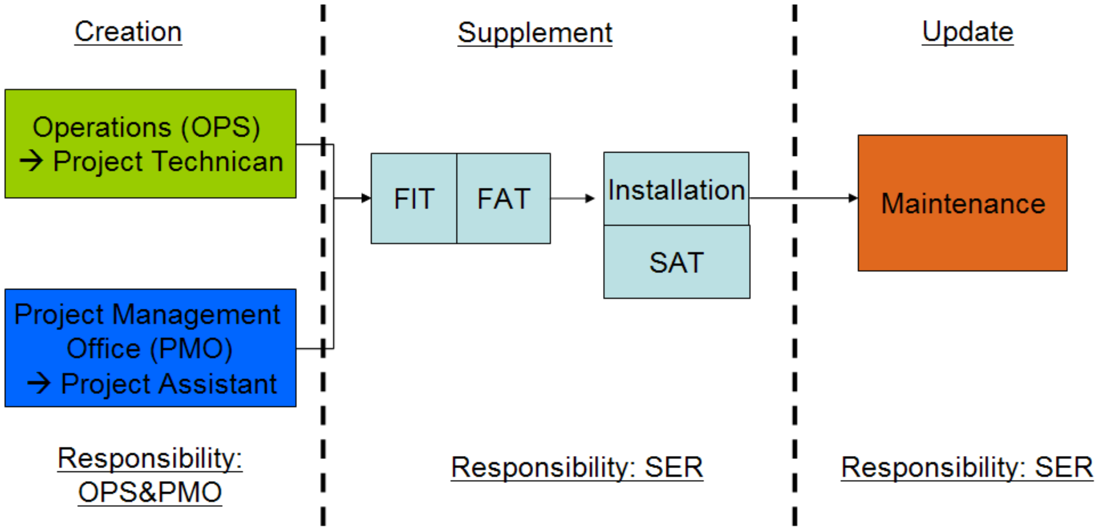


Figure 11: Plan for system structure creation process.

After process and supply chain has been defined, work instructions were created. These include technical commands and operations in EBS user interface. Next step is to point out roles and responsibilities from teams that participate in creation process (PMO & OPS). Finally, training for teams in case, is organized and carried out. When the process has been updated and it is confirmed to be working well, it needs to be updated globally as well. This ensures coherent global ISB for system structures.

4.3 Installed Base Maintenance

As important as creating a valid installed base, it is to maintain it properly. ISB maintenance procedures are part of standard service processes. Furthermore, ISB maintenance instructions are integrated to service process instructions. After sales benefit greatly from maintaining installed base. Field service (FIS) engineers need to have up-to-date information of the sites and products they have to perform service. Technical Support (TES) has to have correct information of all the products and configuration that the customer has, to be able to give good service. Depot Service (DES) needs to have correct information about the products in ISB to be able to perform various tasks for products (repair, calibration, etc). Also, other functions in company can utilize a valid ISB, such as Sales, Marketing and Product and Technology (PTE).

After-sales services play a significant role in the second half of a product's life cycle. After a product is manufactured and delivered to the customer there is a demand to maintain installed base information and to keep it up to date. Service-lines usually have the best knowledge of what actions or changes have been taken or made concerning the product, i.e. ISB information. On the other hand, service business, as maintenance operations, needs reliable information about products and service events, which have accumulated during the life cycle.

After information has been gained in ISB, during delivering the goods to a customer, its maintenance becomes SER responsibility. Even though, different operations in SER take part in updating and maintenance of ISB, all operations in Service use ISB to find information (table 3). Field service need to update ISB, whenever they perform a task to customer products, i.e. change faulty component for a larger system. Depot service automatically updates ISB information when they receive a customer's product. Products location changes when it is received in Depot. Furthermore, individual item information is changed when repair, calibration or item replacement is performed. Technical Support updates ISB information whenever it is noticed that customer information is inaccurate, e.g. serial number mix up with two separate devices that customer owns. Service Development (DEV) takes part in update process whenever new upgrade or analogous is performed. Performance Services (PES) don't have update responsibility and uses ISB mainly to find information.

Table 3: How different functions in Service use Installed Base.

Operation	DEV	FIS	DES	TES	PES
Read	x	x	x	x	x
Update	x	x	x	x	

4.3.1 Work Plan

To carry through this research, first task is to; identify all service process steps that include/should include ISB update in three main service-lines (Tech Support, Depot and Field) (Figure 12). After that, process review and evaluation, for updating, is done if needed. Further, instructions need to be created for these steps, and to include missing steps and instructions to process documentation. When full process is verified, process documentation is upgraded. As was done in system structure creation process, training for applicable service roles is organized. Finally, definition and acceptance for ISB maintenance responsibilities is needed.

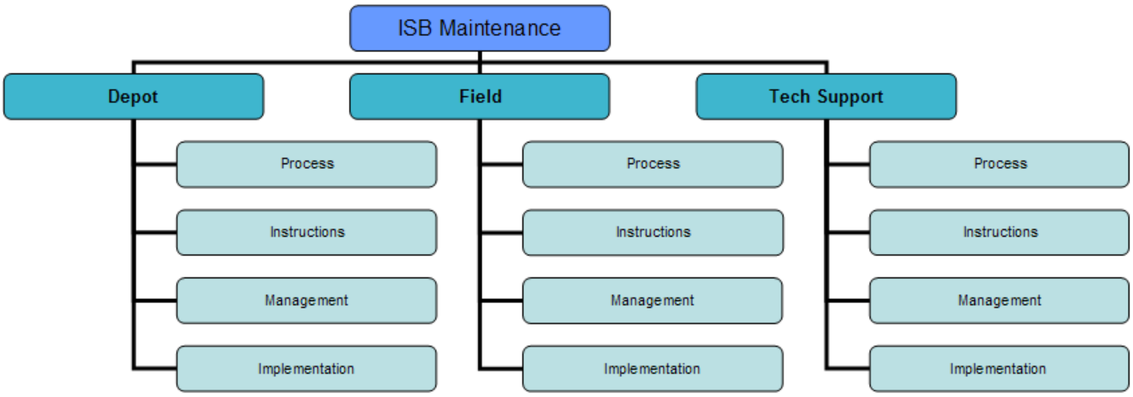


Figure 12: Organization's applications where Installed Base maintenance affects.

Technical Support

First service-line that was taken in review was TES. TES work is more or less straight forward, where the only situation when ISB information is needed is on the very beginning of technical support task (Figure 13 red box). Task starts when customer contacts Vaisala's technical support. Customer informs some malfunction or other issue that needs TES activity. At this point, a TES personnel searches ISB for product and customer information. If it is invalid, for example wrong serial number, a corrective action takes place. A TES personnel updates the ISB information, while offering technical support to a customer

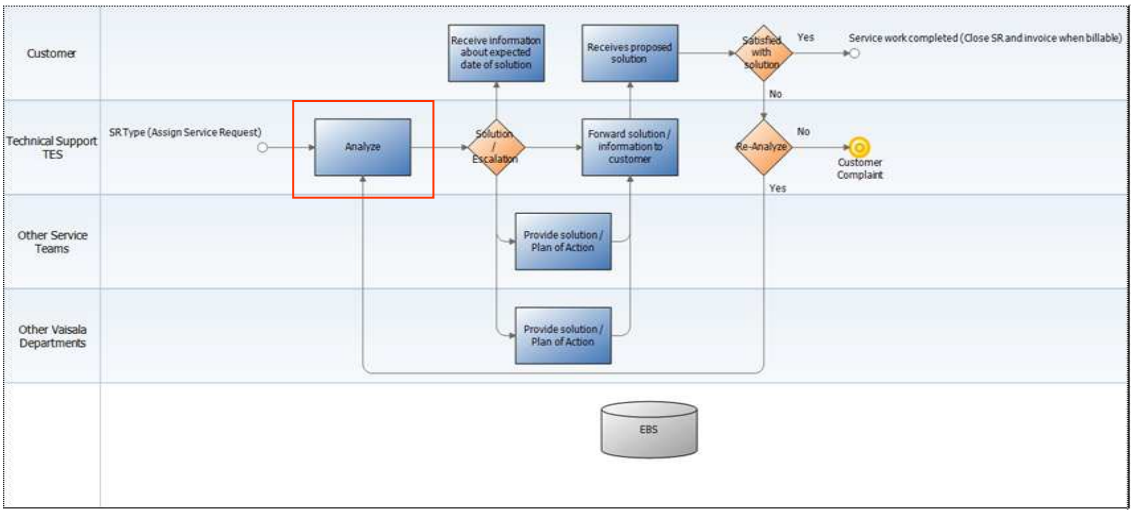


Figure 13: Process description for Technical Support

Field Services

For field services the actions performed, and ISB accessed, are more complex and ubiquitous. Field service performance consists of three different actions; preparation, on-site performance and finally report and follow-up (Figure 14 a, b and c). ISB information is accessed in all of these steps.

In preparation stage (Figure 14a), ISB information is used to fathom current status and the products at customer's site. This is needed, to be able to bring all the correct components to the site, and also to know what the application, that the product is acquired for, is.

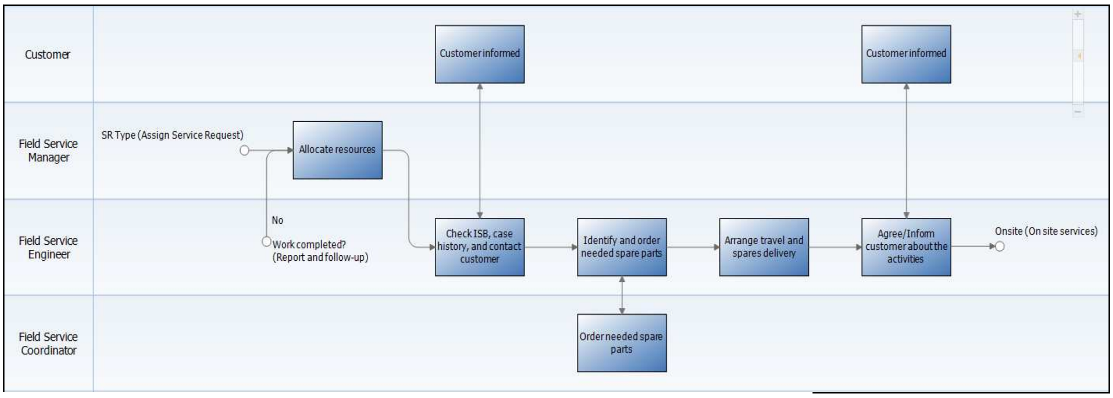


Figure 14a: Process description for Field Services, Prepare.

When field service technician is on site and performs the wanted actions, the ISB information is changed (Figure 14b). At the moment, the ISB update can be done only after the site visit is performed and the technician has returned to the office. For this reason it is vital that the technician records his actions on the customer site. For example, if a malfunctioning part is changed or it is replaced by newer version, technician should record the changed parts and their information, such as serial number or configuration. Doing this, the technician guarantees that the ISB information stays valid and the next site visit is more efficient to carry through.

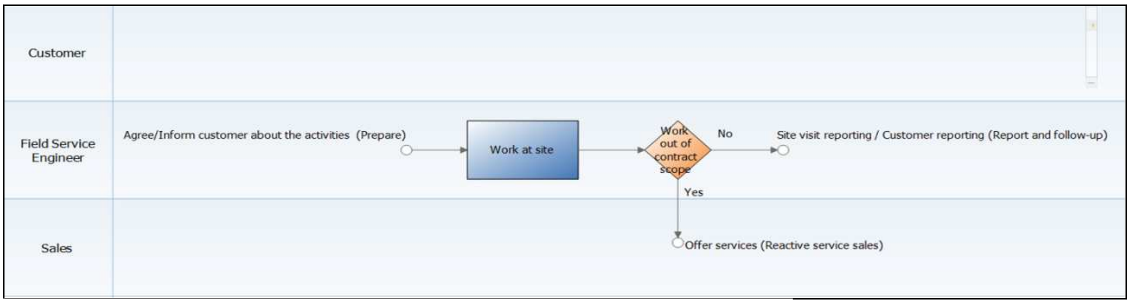


Figure 14b: Process description for Field Services, Onsite.

Final step in field service process is to report and do the follow-up. Here the ISB information plays a vital role. As mentioned above, the information gathered from customer's site and product should be updated to ISB in this stage (figure 14b).

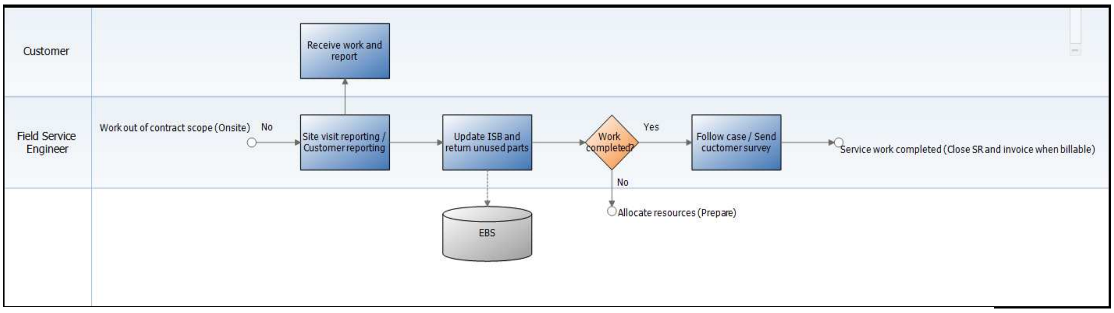


Figure 14c: Process description for Field Services, Report and follow-up.

Depot Services

In depot services ISB information is accessed and updated more than any other service process (Figure 15a, b and c). Like in field services, also in depot services the process can be divined in three separate stages; receive, repair and shipping. In every stage of this process, steps where ISB is accessed are marked with red square.

In receiving step, ISB information changes dramatically (Figure 15a). If item does not exist in EBS ISB, this is the point where ISB instance is first created. This occurs if product is sold to a customer during previous version of ERP was functioning. Also, product owner information changes in this step if needed, e.g. item doesn't not return to previous owner. In any case, the current location changes to be Vaisala office's location. Though, the installation location stays as the customer site, the current location changes to case company's location as until the product is shipped back to the customer. Also, the status of the product always changes. When ever a product is received in depot services the status becomes ' returned for repair' and this stays until product is shipped back. Unfortunately, the system structure is always lost for products that are received in depot services (see chapter 6). This is a malfunction in current EBS system and should be fixed that the process would run efficiently.

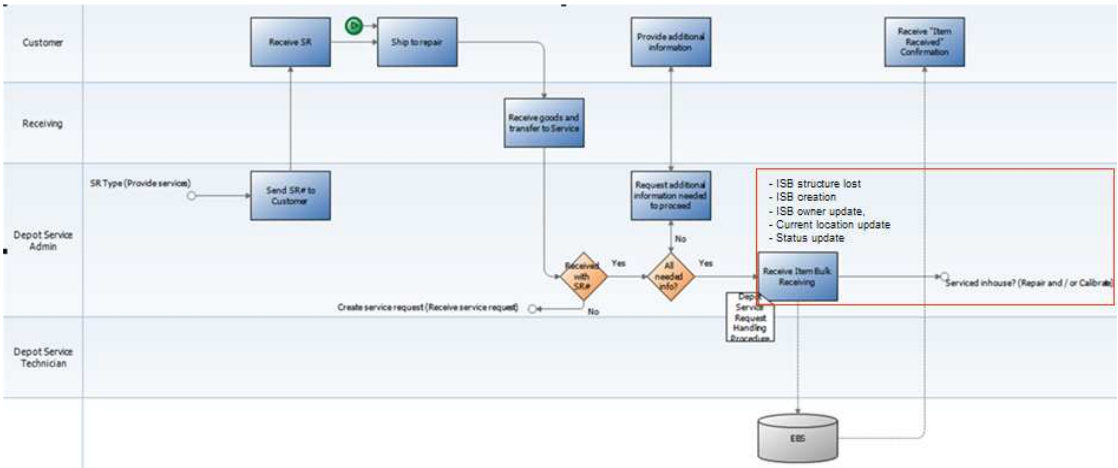


Figure 15a: Process description for Receive in Depot.

When the product undergoes the 'repair' step in depot services some ISB information is updated along the way. Marked by red boxes (figure 15b) are the steps where ISB update happens. Location might get updated if the product is shipped to another Vaisala's faculty in order to receive correct repair performance. Also, as a part of debriefing, the Bill of material (BOM) might change. This means that the product structure changes if some part is replaced or repaired.

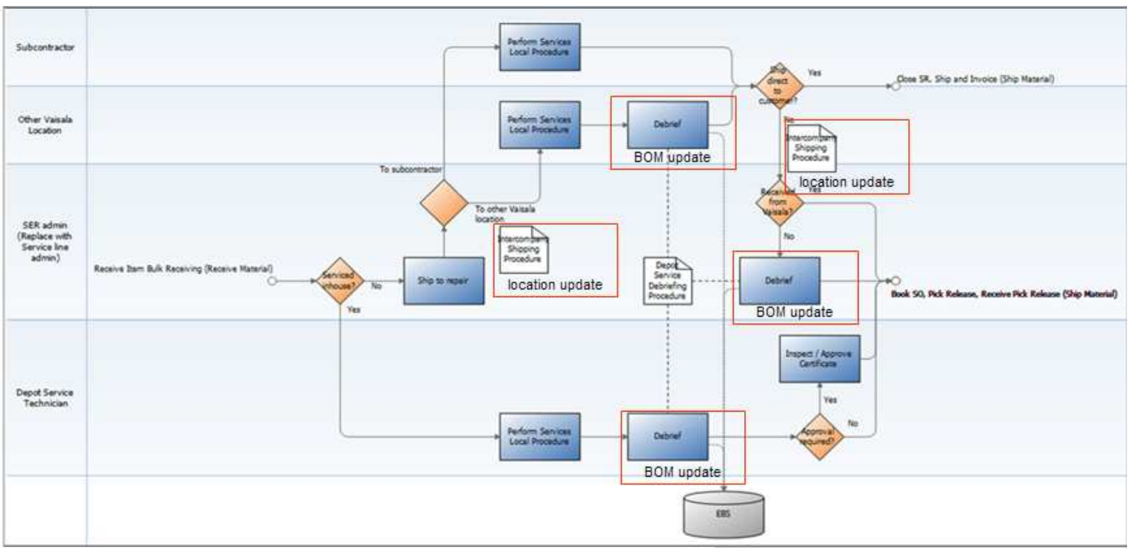


Figure 15b: Process description for Repair in Depot.

The final step of depot services is the shipping. At this point all the depot service tasks are performed and the product is ready to be shipped back to the customer. As happened in the previous stages of depot services, also in shipping step the ISB information is updated (Figure 15 c). Firstly, the inventory updates to correct stage. When the product is shipped to the customer it is removed from Vaisala's inventory and becomes the customer's owning once more. Furthermore, the status and the location of the product changes in this point. As mentioned above, product's status was changed to 'returned for repair' when it was first received in depot, now as a part of shipping the status changes to 'repaired', indicating that it has been depot services and service task has been carried out. Finally, the location changes back to the customer's site. After the shipping the current location becomes same as the installed at location.

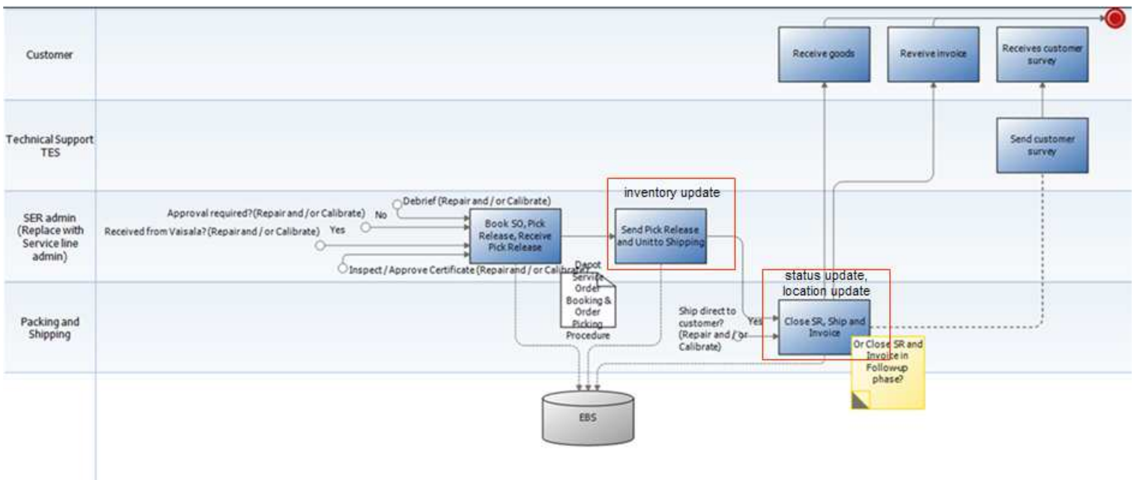


Figure 15c: Process description for Ship in Depot.

4.4 Results

Based on two separate workshops, held with PMO and OPS, respectively, results for creating system structures were gathered. Results are presented in tables below (table 4&5). Even though, results from workshops gathered, were very limited, good understanding on the workload and time needed for the tasks were founded. Based on these results, estimation for needed future work could be estimated.

As explained in the 'Experimental Part' chapter, process for creating a system structure consists of three separate steps; first, creating the actual system-item. Then filling needed attributes for that item, and finally, building up the actual structure from sub-components. These steps are visualized in the tables below, in column 'task'. Row 'misc' is used for additional information that came up during the workshop. In 'Duration' column are presented the time needed for each task. Time was measured and rounded up to ensure big enough time frame. Finally, in 'Remarks' column specific information for each task is presented. This kind of information was vital, because they usually created extra time for task in hand, for example, all the needed attributes for specific system weren't known, and so excess time was needed to find correct values.

In chapter 4.4.2 the results from workshops are combined in one table (table 6). Based on the results from workshops, total time estimation for one year's deliveries, was calculated. Structure of table 6 follows the way of presenting the results as was done in tables 4 and 5. Extra rows in table 6 are 'Number of sales orders' and 'number of sales order lines'. When a system is sold to a customer, a sales order is created. Because each system is sold on a separate sales order, each SO represents new system-item. In a same way, sales order lines tell the number of sub-components that create the system structure. Based on this information, calculations can be made where number of SOs equals number of system-items (z-items), and number of SO lines equals the number of sub-components in the structure.

4.4.1 Workshops

Table 4: System structure workshop with PMO

Medium sized airport delivery		
Task	**Duration**	**Remarks**
Creation of Z-item	1 min	not known, best guess used
Filling attributes	-	unknown, cannot be found from project delivery files
structure creation	1 min & 41 items = 41 mins	
Misc		Site information invalid. Time needed to create correct one

Table 5: System structure workshop with OPS

7 identical small sized weather stations		
Task	**Duration**	**Remarks**
Creation of Z-item	7 x 1 min = 7 mins	
Filling attributes	-	unknown, cannot be found from system delivery files
structure creation	1 min & 49(7 x 7) items = 49 mins	
Misc		-

4.4.2 Time Estimation for Upcoming Workload

Table 6: Estimation for one year's workload, based on 2011 deliveries.

Time estimate for one year's deliveries (based on shipping in 2011)			
Object	Duration	Total duration	Remarks
Number of Sales Orders (SO)	~1 000		
Number of Sales Order lines (SOL)	~14 000		
Time needed for creating z-item	3 min	3 000 min = 50 h (SO x creating z-item)	
time needed for inserting 1 item in configuration	1 min	14 000 min = 233 h = ~6 work weeks (SOL x item configuration)	
Filling attributes Number of attributes	5 sec 23	23 x 5 x 1000 = 230 000 sec = 3833 min = ~62 h (SO x attribute)	Where to find information? Not all attributes are needed for every system
Total time:		50 h + 6 h + 233 h =347 h = 2 work months, 1 work week.	

These results show, that extra time needed will build up to total time of more than two months, which means that 2 extra work months are needed to guarantee valid system structure in ISB, for one year's deliveries.

Results for ISB maintenance are gone through in chapter 5 (Future recommendations), because without fixing current technical malfunctioning in EBS, ISB maintenance cannot be done efficiently in after-sales business.

5 Future recommendations

5.1 Improvements for System Structure Creation Process

5.1.1 Better Search Options

To be able to make system creation process more effective, better search options should be added. Current situation (see Figure 16) doesn't provide searching by Sales Order number, which is by far the most efficient way of having a clear idea which system has been sold to a customer. Additionally, searching by SO number shows all the items, which construct a specific system, at the same time. By current search criteria, it is really time consuming to create the system structure; all the items, which construct a bigger system, needs to be picked individually instead of picking them all at the once.

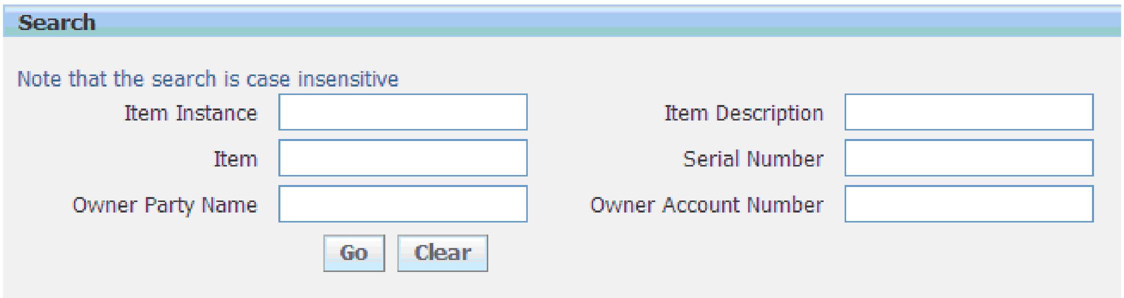


Figure 16: Current search options for creating system configuration.

5.1.2 Updated Process

To make system creation process more fluent, selling the system should be made simpler (Figure 17). If Sales could offer simpler assemblies, the system creation process would become more straightforward. For example, by offering standard systems the system creation process would always be the same and the attributes needed were easier to come up with.

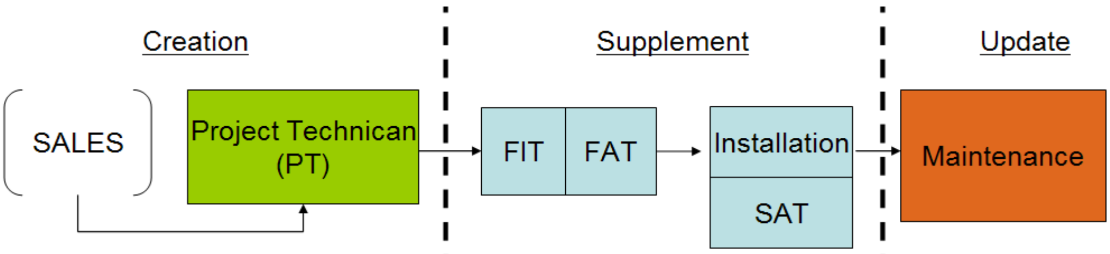


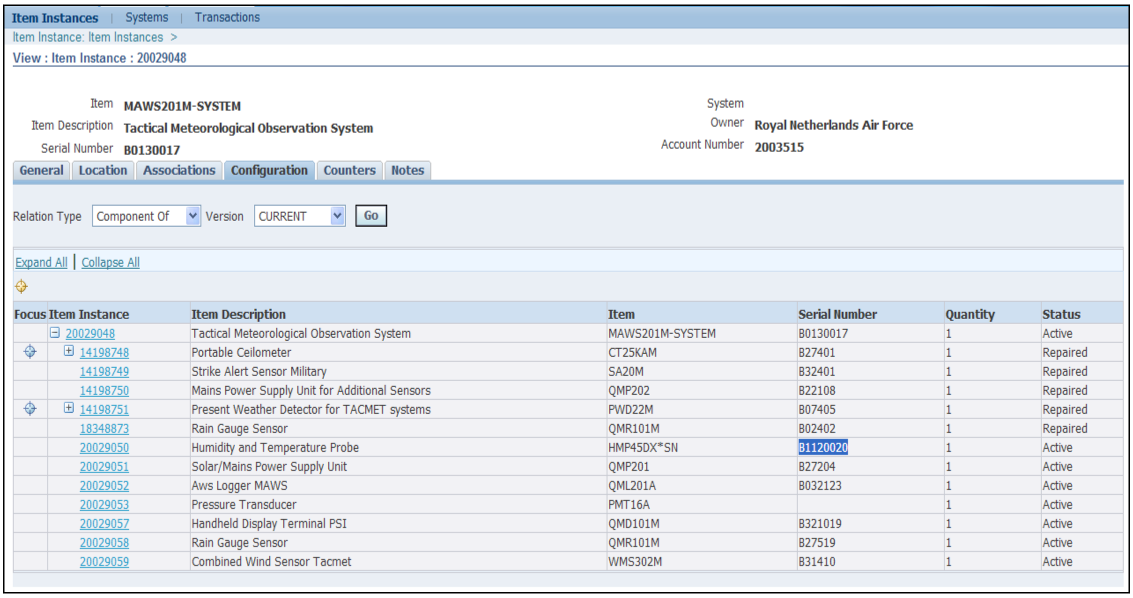
Figure 17: Proposal for future system structure creation process.

5.2 Improvements Installed Base Maintenance in Services

5.2.1 Field Services

When field service engineer performs service request on customer's sites, where physical component is changed or completely removed, installed base should also be updated. As a part of debriefing, field service engineer, records used material. In EBS there is functionality for FIS, where debriefing can be done automatically. Only downside, from installed base's stand point, is that replaced parts don't get removed from the system structure nor does the status change (Figures 18 a, b and c).

Replaced parts go to correct place in structure based on 'Parent Instance'(Figure 18a). EBS has also functionality 'Recovered Instance', which should assign new part as a replaced for old one. Current situation leaves old part untouched and its status stays as before the task (Figure 18b and c).



Focus	Item Instance	Item Description	Item	Serial Number	Quantity	Status
	20029048	Tactical Meteorological Observation System	MAWS201M-SYSTEM	B0130017	1	Active
	14198748	Portable Ceilometer	CT25KAM	B27401	1	Repaired
	14198749	Strike Alert Sensor Military	SA20M	B32401	1	Repaired
	14198750	Mains Power Supply Unit for Additional Sensors	QMP202	B22108	1	Repaired
	14198751	Present Weather Detector for TACMET systems	PWD22M	B07405	1	Repaired
	18348873	Rain Gauge Sensor	QMR101M	B02402	1	Repaired
	20029050	Humidity and Temperature Probe	HMP45DX*SN	B1120020	1	Active
	20029051	Solar/Mains Power Supply Unit	QMP201	B27204	1	Active
	20029052	Aws Logger MAWS	QML201A	B032123	1	Active
	20029053	Pressure Transducer	PMT16A		1	Active
	20029057	Handheld Display Terminal PSI	QMD101M	B321019	1	Active
	20029058	Rain Gauge Sensor	QMR101M	B27519	1	Active
	20029059	Combined Wind Sensor Tacmet	WMS302M	B31410	1	Active

Figure 18 a: ISB at start

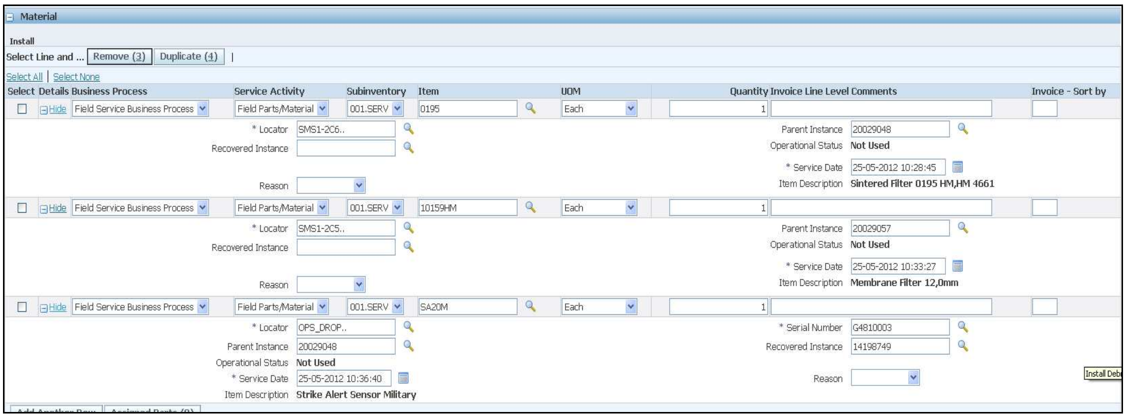


Figure 18b: Debriefed items at main level and in BOM

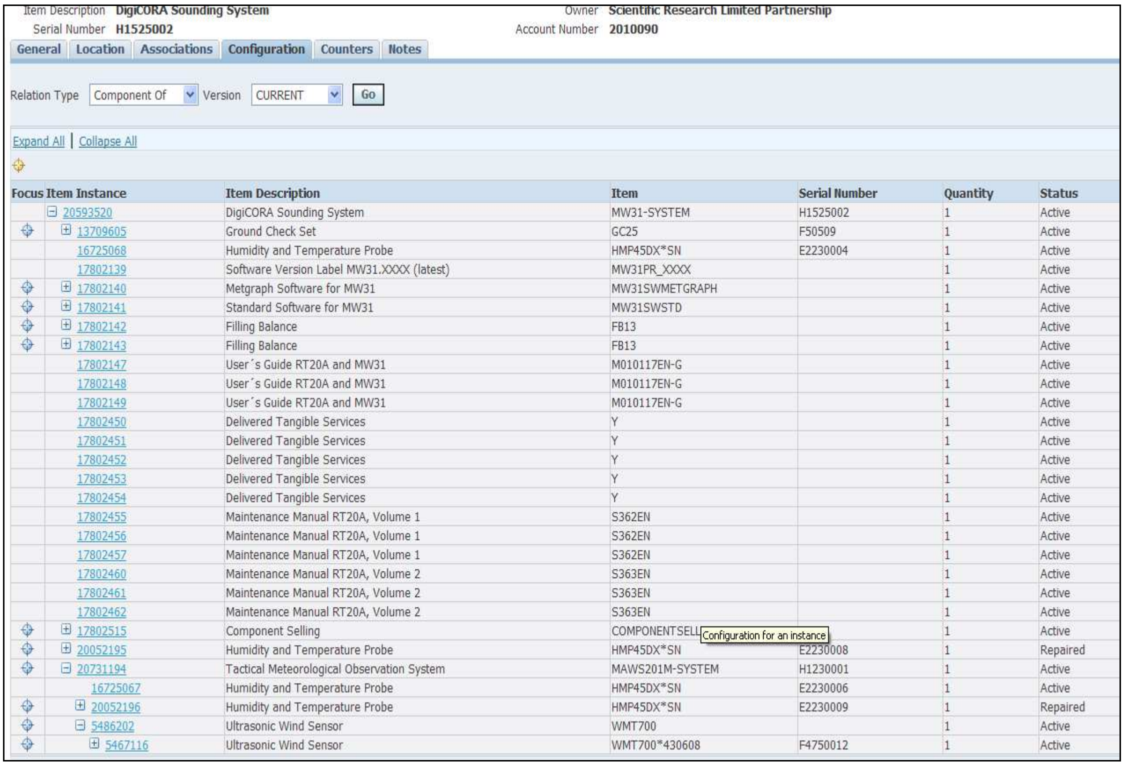
Focus	Item Instance	Item Description	Item	Serial Number	Quantity	Status
	20029048	Tactical Meteorological Observation System	MAWS201M-SYSTEM	B0130017	1	Active
	14198748	Portable Ceilometer	CT25KAM	B27401	1	Repaired
	14198749	Strike Alert Sensor Military	SA20M	B32401	1	Repaired
	14198750	Mains Power Supply Unit for Additional Sensors	QMP202	B22108	1	Repaired
	14198751	Present Weather Detector for TACMET systems	PWD22M	B07405	1	Repaired
	18348873	Rain Gauge Sensor	QMR101M	B02402	1	Repaired
	18681381	Strike Alert Sensor Military	SA20M	G4810003	1	Replacement
	19231854	Weather Transmitter	WXT520		1	Active
	19231855	Weather Transmitter	WXT520		1	Active
	20029050	Humidity and Temperature Probe	HMP45DX*SN	B1120020	1	Returned for Repair
	20029051	Solar/Mains Power Supply Unit	QMP201	B27204	1	Active
	20029052	Aws Logger MAWS	QML201A	B032123	1	Active
	20029053	Pressure Transducer	PMT16A		1	Active
	20029057	Handheld Display Terminal PSI	QMD101M	B321019	1	Active
	20729193	Membrane Filter 12,0mm	10159HM		1	Replacement
	20729192	Sintered Filter 0195 HM,HM 4661	0195		1	Replacement

Figure 18c: Structure once debrief completed.

5.2.2 Depot Services

As mentioned in the previous chapters the depot process loses the system structure (Figure 19 and 20). The 'receive' step at depot services loses the link between the system-item and the item underneath it (Figures 19 a,b,c). Additionally, the structure is also lost in more complex structure; items (HMP45DX*SN) in sub structure (MAWS201M-SYSTEM) will disappear in same way as explained above (Figure 19c).

To make whole system structure creation process rational, these kinds of malfunctions need to be fixed. Otherwise, when ever system structure is created in EBS ISB, the structure is lost during time when services are performed for any of those devices.



Item Description **DigiCORA Sounding System** | Owner **Scientific Research Limited Partnership**
Serial Number **H1525002** | Account Number **2010090**

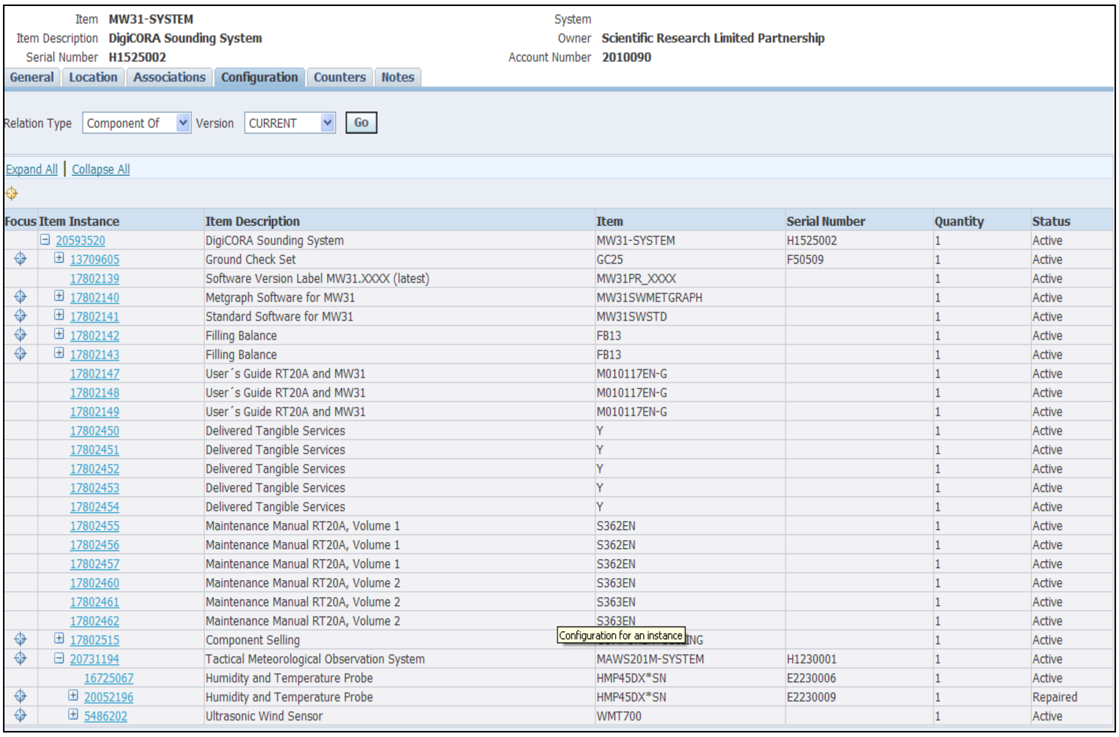
General | Location | Associations | Configuration | Counters | Notes

Relation Type Component Of | Version CURRENT | Go

Expand All | Collapse All

Focus	Item Instance	Item Description	Item	Serial Number	Quantity	Status
	20593520	DigiCORA Sounding System	MW31-SYSTEM	H1525002	1	Active
	13709605	Ground Check Set	GC25	F50509	1	Active
	16725068	Humidity and Temperature Probe	HMP45DX*SN	E2230004	1	Active
	17802139	Software Version Label MW31.XXXX (latest)	MW31PR_XXXX		1	Active
	17802140	Metgraph Software for MW31	MW31SWMETGRAPH		1	Active
	17802141	Standard Software for MW31	MW31SWSTD		1	Active
	17802142	Filling Balance	FB13		1	Active
	17802143	Filling Balance	FB13		1	Active
	17802147	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802148	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802149	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802450	Delivered Tangible Services	Y		1	Active
	17802451	Delivered Tangible Services	Y		1	Active
	17802452	Delivered Tangible Services	Y		1	Active
	17802453	Delivered Tangible Services	Y		1	Active
	17802454	Delivered Tangible Services	Y		1	Active
	17802455	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802456	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802457	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802460	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802461	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802462	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802515	Component Selling	COMPONENTSELL	Configuration for an instance	1	Active
	20052195	Humidity and Temperature Probe	HMP45DX*SN	E2230008	1	Repaired
	20731194	Tactical Meteorological Observation System	MAWS201M-SYSTEM	H1230001	1	Active
	16725067	Humidity and Temperature Probe	HMP45DX*SN	E2230006	1	Active
	20052196	Humidity and Temperature Probe	HMP45DX*SN	E2230009	1	Repaired
	5486202	Ultrasonic Wind Sensor	WMT700		1	Active
	5467116	Ultrasonic Wind Sensor	WMT700*430608	F4750012	1	Active

Figure 19a: ISB at start



Item **MW31-SYSTEM** | System
Item Description **DigiCORA Sounding System** | Owner **Scientific Research Limited Partnership**
Serial Number **H1525002** | Account Number **2010090**

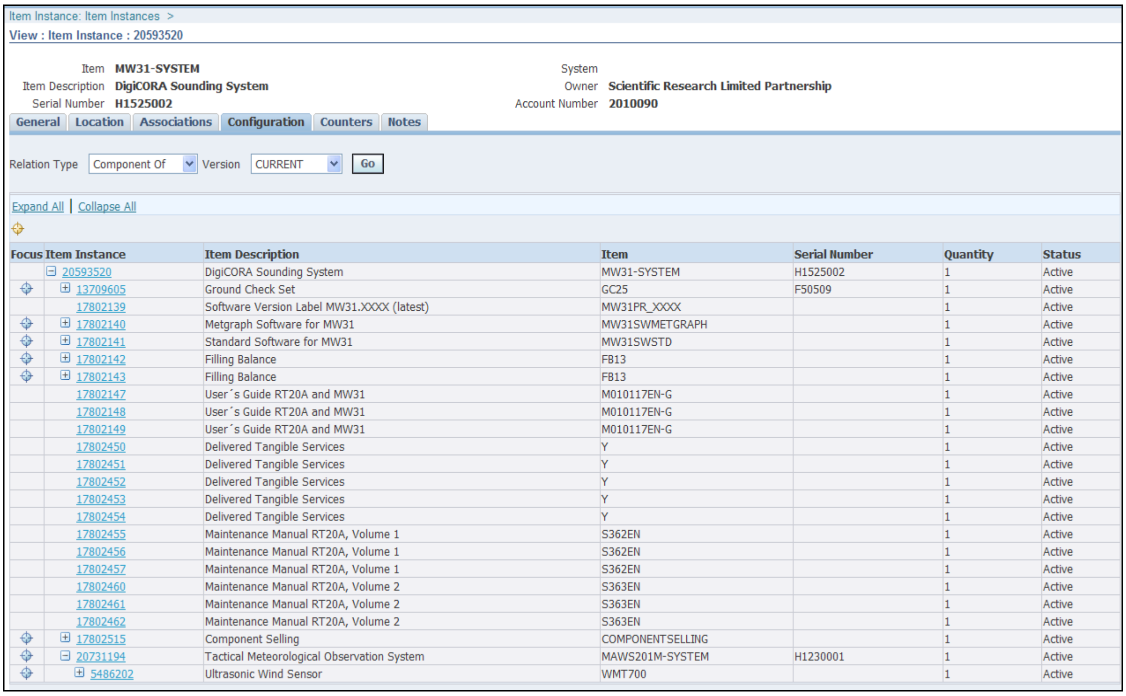
General | Location | Associations | Configuration | Counters | Notes

Relation Type Component Of | Version CURRENT | Go

Expand All | Collapse All

Focus	Item Instance	Item Description	Item	Serial Number	Quantity	Status
	20593520	DigiCORA Sounding System	MW31-SYSTEM	H1525002	1	Active
	13709605	Ground Check Set	GC25	F50509	1	Active
	17802139	Software Version Label MW31.XXXX (latest)	MW31PR_XXXX		1	Active
	17802140	Metgraph Software for MW31	MW31SWMETGRAPH		1	Active
	17802141	Standard Software for MW31	MW31SWSTD		1	Active
	17802142	Filling Balance	FB13		1	Active
	17802143	Filling Balance	FB13		1	Active
	17802147	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802148	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802149	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802450	Delivered Tangible Services	Y		1	Active
	17802451	Delivered Tangible Services	Y		1	Active
	17802452	Delivered Tangible Services	Y		1	Active
	17802453	Delivered Tangible Services	Y		1	Active
	17802454	Delivered Tangible Services	Y		1	Active
	17802455	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802456	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802457	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802460	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802461	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802462	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802515	Component Selling	Configuration for an instance ING		1	Active
	20731194	Tactical Meteorological Observation System	MAWS201M-SYSTEM	H1230001	1	Active
	16725067	Humidity and Temperature Probe	HMP45DX*SN	E2230006	1	Active
	20052196	Humidity and Temperature Probe	HMP45DX*SN	E2230009	1	Repaired
	5486202	Ultrasonic Wind Sensor	WMT700		1	Active

Figure 19b: Active and repaired HMP45DX*SN missing once received to Service (Serial numbers: E2230004 and E2230008)


Item Instance: Item Instances >
View : Item Instance : 20593520

Item **MW31-SYSTEM**
Item Description **DigiCORA Sounding System**
Serial Number **H1525002**
System
Owner **Scientific Research Limited Partnership**
Account Number **2010090**

General | Location | Associations | Configuration | Counters | Notes

Relation Type Component Of Version CURRENT Go

Expand All | Collapse All

Focus	Item Instance	Item Description	Item	Serial Number	Quantity	Status
	20593520	DigiCORA Sounding System	MW31-SYSTEM	H1525002	1	Active
	13709605	Ground Check Set	GC25	F50509	1	Active
	17802139	Software Version Label MW31.XXXX (latest)	MW31PR_XXXX		1	Active
	17802140	Metgraph Software for MW31	MW31SWMETGRAPH		1	Active
	17802141	Standard Software for MW31	MW31SWSTD		1	Active
	17802142	Filling Balance	FB13		1	Active
	17802143	Filling Balance	FB13		1	Active
	17802147	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802148	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802149	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802450	Delivered Tangible Services	Y		1	Active
	17802451	Delivered Tangible Services	Y		1	Active
	17802452	Delivered Tangible Services	Y		1	Active
	17802453	Delivered Tangible Services	Y		1	Active
	17802454	Delivered Tangible Services	Y		1	Active
	17802455	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802456	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802457	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802460	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802461	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802462	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802515	Component Selling	COMPONENTSELLING		1	Active
	20731194	Tactical Meteorological Observation System	MAWS201M-SYSTEM	H1230001	1	Active
	5486202	Ultrasonic Wind Sensor	WMT700		1	Active

Figure 19c: **Items not recovered to structure once items shipped back to customer.**

Furthermore, ISB loses the structure within single product (Figure 20 a,b,c). This happens also in 'receive' step in depot services. Products are designed in a way that there is a top level item, called assemble to order (ATO) model, and underneath that the actual configuration, ATO items. When service is performed to this kind of products in depot services, the link between the ATO model and the ATO items is lost (Figure 20b). On top of that the status for top level item stays active (Figure 20b), while the status for the configuration changes to returned for repair (Figure 20c).

Focus	Item Instance	Item Description	Item	Serial Number	Quantity	Status
	20593520	DigiCORA Sounding System	MW31-SYSTEM	H1525002	1	Active
	13709605	Ground Check Set	GC25	F50509	1	Active
	17802139	Software Version Label MW31.XXXX (latest)	MW31PR_XXXX		1	Active
	17802140	Metgraph Software for MW31	MW31SWMETGRAPH		1	Active
	17802141	Standard Software for MW31	MW31SWSTD		1	Active
	17802142	Filling Balance	FB13		1	Active
	17802143	Filling Balance	FB13		1	Active
	17802147	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802148	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802149	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802450	Delivered Tangible Services	Y		1	Active
	17802451	Delivered Tangible Services	Y		1	Active
	17802452	Delivered Tangible Services	Y		1	Active
	17802453	Delivered Tangible Services	Y		1	Active
	17802454	Delivered Tangible Services	Y		1	Active
	17802455	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802456	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802457	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802460	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802461	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802462	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802515	Component Selling	COMPONENTSELLING		1	Active
	20731194	Tactical Meteorological Observation System	MAWS201M-SYSTEM	H1230001	1	Active
	5486202	Ultrasonic Wind Sensor	WMT700		1	Active
	5467116	Ultrasonic Wind Sensor	WMT700*430608	F4750012	1	Active
	5486176	Feature	WMT700.WMT70RANGE		1	Active
	5486178	Feature	WMT700.WMT70TEMPRANGE		1	Active
	5486180	Feature	WMT700.WMT70HEATING		1	Active
	5486182	Feature	WMT700.WMT70SERIALOUT		1	Active
	5486184	Feature	WMT700.WMT70MSGFORMAT		1	Active
	5486186	Feature	WMT700.WMT70UNITS		1	Active
	5486188	Feature	WMT700.WMT70AOUTSPD		1	Active
	5486190	Feature	WMT700.WMT70AOUTDIR		1	Active
	5486192	Feature	WMT700.WMT70CABLE		1	Active
	5486194	Feature	WMT700.WMT70MOUNTING		1	Active
	5486196	Feature	WMT700.WMT70POWER		1	Active
	5486198	Feature	WMT700.WMT70ACC		1	Active
	5486200	Feature	WMT700.WMT70MANUAL		1	Active

Figure 20a: Ato item (WMT700*430608) under ATO model.

Focus	Item Instance	Item Description	Item	Serial Number	Quantity	Status
	20593520	DigiCORA Sounding System	MW31-SYSTEM	H1525002	1	Active
	13709605	Ground Check Set	GC25	F50509	1	Active
	17802139	Software Version Label MW31.XXXX (latest)	MW31PR_XXXX		1	Active
	17802140	Metgraph Software for MW31	MW31SWMETGRAPH		1	Active
	17802141	Standard Software for MW31	MW31SWSTD		1	Active
	17802142	Filling Balance	FB13		1	Active
	17802143	Filling Balance	FB13		1	Active
	17802147	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802148	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802149	User´s Guide RT20A and MW31	M010117EN-G		1	Active
	17802450	Delivered Tangible Services	Y		1	Active
	17802451	Delivered Tangible Services	Y		1	Active
	17802452	Delivered Tangible Services	Y		1	Active
	17802453	Delivered Tangible Services	Y		1	Active
	17802454	Delivered Tangible Services	Y		1	Active
	17802455	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802456	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802457	Maintenance Manual RT20A, Volume 1	S362EN		1	Active
	17802460	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802461	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802462	Maintenance Manual RT20A, Volume 2	S363EN		1	Active
	17802515	Component Selling	COMPONENTSELLING		1	Active
	20731194	Tactical Meteorological Observation System	MAWS201M-SYSTEM	H1230001	1	Active
	5486202	Ultrasonic Wind Sensor	WMT700		1	Active

Figure 20b: Disappeared from structure once received to service, WMT700 status = active

Focus	Item Instance	Item Description	Item	Serial Number	Quantity	Status
	5467116	Ultrasonic Wind Sensor	WMT700*430608	F4750012	1	Returned for Repair
	5486176	Feature	WMT700.WMT70RANGE		1	Returned for Repair
	5486178	Feature	WMT700.WMT70TEMPRANGE		1	Returned for Repair
	5486180	Feature	WMT700.WMT70HEATING		1	Returned for Repair
	5486182	Feature	WMT700.WMT70SERIALOUT		1	Returned for Repair
	5486184	Feature	WMT700.WMT70MSGFORMAT		1	Returned for Repair
	5486186	Feature	WMT700.WMT70UNITS		1	Returned for Repair
	5486188	Feature	WMT700.WMT70AOUTSPD		1	Returned for Repair
	5486190	Feature	WMT700.WMT70AOUTDIR		1	Returned for Repair
	5486192	Feature	WMT700.WMT70CABLE		1	Returned for Repair
	5486194	Feature	WMT700.WMT70MOUNTING		1	Returned for Repair
	5486196	Feature	WMT700.WMT70POWER		1	Returned for Repair
	5486198	Feature	WMT700.WMT70ACC		1	Returned for Repair
	5486200	Feature	WMT700.WMT70MANUAL		1	Returned for Repair

Figure 20c: WMT700*430608 Status = Returned for repair

5.3 Other Recommendations

5.3.1 Legacy Data

To be able to take all benefit out of goods sold to a customer in the past years, it is vital to be able to transfer all legacy data from previous ERP to current operating ERP. Lots of individual instruments, as well as larger systems, have been sold to customers in the past decades. These equipments are still functioning and service is offered to the customer. For this reason, it is essential that ISB could be updated regarding all these equipments. Without the information in hand, it is very difficult to run service operations fluently. On top of that, all up-selling is nearly impossible, because it is hard to know what kind of equipment the customer has, or has some upgrades been sold.

5.3.2 Portable Data Collection for Field Services

For field services, portable data collection could be beneficial. Whenever field engineer is on customer's site, it would be sensible that changes made on customer's product would also be able to see from ISB simultaneously. For example, if technician changes malfunctioning part, and replaces it with new one, ISB would be updated at the same time. This could be made possible by portable device with an internet connection. From customer's site, the technician contacts company's EBS and updates the ISB as a part of his field service task. This way data would always be accurate and possibility for updating wrong information would be minimized, e.g. technician updating ISB as a part of debriefing process after arriving back to the office.

5.3.3 Creation of System-items

Implementation of z-item creation in product creation process. Whenever company's launches new device or it is found out that some system-items are missing, life cycle management (LCM) team should be notified and creation of new z-item should be implemented in that team. This process guarantees that all needed z-items are available in EBS ISB.

6 Discussion

Current ERP functionalities don’t allow fluent and efficient creation and maintenance of ISB. As an outcome of product structure design and ERP in use, that don't function well together; a lot of excess work and time are needed to complete ISB related tasks. If improvements, suggested in previous chapter, are made, more efficient data entering and updating is guaranteed. On top of that, data in ISB stays more valid and do not get corrupted over time.

Results gathered from workshops and interviews show that noteworthy efforts need to be made in order to have valid information in ISB. Furthermore, this work is not divided evenly over the year, but peaks in system or project deliveries are formed, which makes hiring an additional manpower challenging.

Limited resources in different teams create problem, when trying to direct system creation process within the company. As was seen in results section; one year's deliveries create excess work of more than two months. For any team it is a struggle to adapt this much of extra work, not to mention the instructions and training needed to operate fluently.

Even though attributes, which were created for system-items, give a lot of extra necessary information, the usage could be improved. For example, system-items have now location attributes, such as latitude or longitude. At the moment this information is found under the system-item, i.e. the actual device. In future, it would make more sense that this kind of information could be found under the site information. Because ISB has hierarchical structure, and site is above the device, storing location data to site level would be more effective. Since, the site is the actual location where the products are. Also, the maintenance of attributes quickly becomes huge task. For instance, customer can have a site with several different systems. Now the latitude and longitude attributes need to be entered separately to each of these system, while on the other hand the attributes could be under site information, when it would be enough to enter the values only once.

7 Conclusion

The research problem of this thesis focused on how to create valid installed base and how it is maintained in company's after-sales department, especially for larger assemblies that have a system structure. This Master's thesis was to study how the current process is carried out and to identify the advantages and challenges in that process. The study was necessary because the company's information management practices were not at sufficient level and the company's information management was handled by many different practices. Complicating the situation, previously Vaisala has had several installed bases and ERP depending on geographical location, but has recently unified the organization to one database without sufficiently addressing these local practices. Additionally, policies, responsibilities and instructions were largely incomplete.

The research problem was approached first from introduction to service business and then through a review of the literature and empirical research. The literature review was done to better understand the basic concepts related to after-sales business and installed base. Additionally, product life cycle management was introduced because ISB and services are functional during a products' entire life time. Chapter 3 was used to better describe the need for functioning installed base in Vaisala, and also how current ISB information is created, and all the different service lines that benefit from valid ISB were introduced with their special demands explained.

The next two chapters addressed the actual research problem. The main issue was that systems sold to a customer don't have structure in place in EBS ISB. This creates situation where as-built system structures were lost and confused with different goods sold to a customer. The chosen solution for this was to manually create the system structure after shipment, and for this activity the system supply chain was examined to identify the optimal method to enable this process. Based on the findings, the system structure creation process was implemented to be part of the supply chain. Furthermore, instructions and training were done to guarantee successful implementation.

After the structure is initially created, ongoing ISB maintenance processes for all service-lines were examined and stages were ISB is updated were identified. The stages where ISB information didn't update as wanted were examined more thoroughly and corrective actions were put in place.

In chapter 6 the consequences of not fully operating process were discussed. Several improvements were introduced based on the outcomes. These improvements were aimed at both the creation and maintenance part of research problem. Although the process was updated and new workarounds were introduced, the main outcome of the findings was that current ERP functionalities heavily limit the efficient and effective use of EBS ISB. For creation and maintenance process technical limitations produce a situation where alternative ways to enter data into ISB is needed. This creates large amount of waste, in both time and effort. Despite this fact, improvements for current processes were made and a new process was proposed. Furthermore, a pilot project was launched to gather more information.

Based on the results gained from the research, it was possible to update the current processes and therefore significant steps forward towards the desired condition were made. Without this effort the company's ISB would continue growing into state where the information is inaccurate and it would continue to be impossible to recognize & service systems. Furthermore, thanks to this research, technical limitations in ERP system were recognized and corrective actions were identified.

References

[1] Wise, R. & Baumgartner, P., *Go downstream, the new profit imperative in manufacturing*. Harvard Business Review, vol. 77, no. 5, pp. 133–141. 1999.

[2] Technology Review. *Seizing the White Space: Innovative Service Concepts in the United States.* 205/2007. Helsinki 2007.

[3] TEKES Review. *The Future of Service Business Innovation*. 272/2010. Helsinki 2010

[4] Insight from EIRMA 2011 Learning Group: "The Service-Centered R&D" *Making the transition to service innovation.* Paris 2011

[5] Knecht, T., Leszinski, R., Weber, F., *Memo to a CEO*. The McKinsey Quarterly, vol. 4. pp. 79–86. 1993.

[6] Goffin, K. & New, C., "*Customer support and new product development: An exploratory study".* International Journal of Operations & Production Management, vol. 21, no. 3, pp. 275–301. 2001.

[7] Rogelio, O. & Robert, K., *Managing the transition from products to services.* International Journal of Service Industry Management Vol. 14 No. 2, pp. 160-172. 2003.

[8] Prahalad, C. K. & Hamel, G., *Competing for the future*. Harvard Business School Press, Boston. 1994.

[9] Parasuraman, A., *Customer service in business-to-business markets: An agenda for research. Journal of Business & Industrial Marketing*, vol. 13, iss. 4/5, pp. 309–321. 1999.

[10] Dekker, R., Pinçe, C., Zuidwijk R., Jalil, M. N., *On the use of installed base information for spare parts logistics: a review of ideas and industry practice.* Research Paper, Econometric Institute 2010.

[11] Ala-Risku, T., *INSTALLED BASE INFORMATION: Ensuring Customer Value and Profitability after the Sale.* Helsinki University of Technology. Department of Industrial Engineering and Management. Doctoral Dissertation Series 2009/6 Espoo 2009

[12] Viitakangas, J., *Efficient installed base information management and utilization in global after sales service*

business. Master's thesis. Lappeenranta University of Technology. 2011

[13] http://oxforddictionaries.com/ cited 21.06.2012

[14] Sääksvuori, A. & Immonen, A., *Product lifecycle management.* 3rd edition. Berlin: Springer. 2002.

[15] Grönroos, C., *Service Management and Marketing- Customer management in Service Competion.* 3rd edition. Chichester: John Wiley & Son Ltd. 2007

[16] Spring, M. & Araujo, L., *Service, services and products: rethinking operations strategy.* International Journal of Operations & Production Management (Emerald Group Publishing) vol 29, no. 5. P 444-467. 2009.

[17] Callon, M., Méadel, C., Rabeharisoa, V., *The economy of qualities.* Economy and Society, vol. 31, no. 2, pp. 194–217. 2002.

[18] Sampson, S. E. & Froehle, C. M., *Foundations and implications of a proposed unified services theory*. Production and Operations Management, vol. 15, no. 2, pp. 329–343. 2006.

[19] Samli, A., Jacobs, L., Wills, J., *What presale and postsale services do you need to be competitive.* Industrial Marketing Management, vol. 21, pp. 33–41. 1992

[20] Frambach, R., Wels-Lips, I., Gündlach, A., *Proactive product service strategies–An application in the European health market.* Industrial Marketing Management, vol. 26, pp. 341–352. 1997.

[21] Mathieu, V., *Product services: From a service supporting the product to a service supporting the client.* Journal of Business and Industrial Marketing, vol. 16, no. 1, pp. 39–58. 2001

[22] Cavalieri, S., Gaiardelli, P., Ierace, S., *Aligning strategic profiles with operational metrics in after-sales service.* International Journal of Productivity and Performance Management, vol. 56, no. 5/6, pp. 436–455. 2007

[23] Baines, T. S., Lightfoot, H. W., Evans, S., Neely, A., Greenough, R., Peppard, J., Roy, R., Shehab, E., Braganza, A., Tiwari, A., Alcock, J. R., Angus, J. P., Bastil, M., Cousens, A., Irving, P., Johnson, M., Kingston, J., Lockett,

H., Martinez, V., Michele, P., Tranfield, D., Walton, I. M., Wilson H., *State-of-the-art in product-service systems*. Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture, vol. 221, no. 10, pp. 1543–1552. 2007

[24] Martin H.H., *Contracting out maintenance and a plan for future research.* Journal of Quality in Maintenance Engineering, vol. 3, no. 2, pp. 81–90. 1997

[25] Arts, R.H.P.M., Knapp, G. M., Mann Jr, L., *Some aspects of measuring maintenance performance in the process industry.* Journal of Quality in Maintenance Engineering, vol. 4, no. 1, pp. 6–11. 1998

[26] Oliva, R. & Kallenberg, R. *Managing the transition from products to services.* International Journal of Service Industry Management, vol. 14, no. 2, pp. 160–172. 2003

[27] Roza, G., *Databases: Organizing information.* The RosenPublishing Group,1st Edition, 2011.

[27] http://help.sap.com cited 28.6.2012

[28] Papinniemi, J. & Kärkkäinen, H., *Product information modelling for supporting inter-organizational networking and collaborative product lifecycle management*, ISPIM-08, Tours, France 15-18 June 2008

[29] Rangan, R. M., Rohde, S. M. Peak, R., *Streamlining product lifecycle processes: A survey of product lifecycle management implementations, directions, and challenges.* Journal of Computing and Information Science in Engineering, vol. 5, pp. 227–237. 2005

[30] Brandao, R. & Wynn, M., *Product Lifecycle Management Systems and Business Process Improvement – A Report on Case Study Research*. University of Gloucestershire. 2008

[31] Peltonen, H., Pitkänen, O., Sulonen, R., *Process-based view of product datamanagement.* Computers in Industry, vol. 31, pp. 195–203. 1996

[32] Gomes, J. F., Weerd-Nederhof, P. C. de, Pearson, A. W., Cunha, M. P. e, *Is more always better? An exploration of the differential effects of functional integration on performance in new product development.* Technovation, vol. 23, pp. 185–191. 2003

[33] Trott, P., *The role of market research in the development of discontinuous newproducts.* European Journal of Innovation Management, vol. 4, no. 3, pp. 117–125. 2001.

[34] http://www.ldoceonline.com/ cited 28.06.2012

[35] Borchers, H. W. & Karandikar, H., *A data warehouse approach for estimating and characterizing the installed base of industrial products.* Proceedings of International Conference on Service Systems and Service Management, pp. 53–59. 2006

[36] Galbraith, J. R., *Designing complex organizations*, Addison-Wesley, Reading, MA. 1973

[37] Campbell, A. J., *"Creating customer knowledge competence: Managing customer relationship management programs strategically,"* Industrial Marketing Management, vol. 32, pp. 375–383. 2003

[38] Zablah, A. R., Bellenger, D. N., Johnston, W. J., *.An evaluation of divergent perspectives on customer relationship management: Towards a common understanding of an emerging phenomenon.* Industrial Marketing Management, vol. 33, pp. 475–489. 2004

[39] Cooper, R. G., and Kleinschmidt, E. J., *Winning businesses in product development: The critical success factors*. Research Technology Management, vol. 50, no. 3, pp. 52–66. 2007

[40] Rai, B. & Singh, N., *Hazard rate estimation from incomplete and unclean warranty data.* Reliability Engineering and System Safety, vol. 81, pp. 79–92. 2003

[41] Hörhammer, K., *Service process development for the installed base project,* 2001

[42] http://www.vaisala.com/en/investors/annualreport2011/Pages/default.aspx cited 20.062012

[43] http://www.kauppalehti.fi/5/i/porssi/porssikurssit/osake/?klid=1043 cited 20.062012

[44] http://www.vaisala.com/en/corporate/organization/ cited 20.06.2012

[45] Sobek II, D. K., *Principles that Shape Product Development Systems: A Toyota-Chrysler Comparison*, Ph.D. dissertation. The University of Michigan, Ann Arbor, 1997.

[46] Womack, J. P., Jones, D. T., Roos, D., *The Machine that Changed the World: The Story of Lean Production,* HarperPerennial, New York, 1990.

[47] Shook, J., *Managing to Learn, Using the A3 management process to solve problems, gain agreement, mentor and lead.* Lean Enterprise Institute, 2008.

Apendix A - A3 reports

Installed Base -Review

initials

ISU	TUK	03.2012

I. Background

- Since 1995 all Vaisala delivered products have been documented to create ISB.
- Beginning of 21st century Kenneth Hörnhammer conducted ISB development project with similar targets.
- After development project Vaisala ISB has continued to grow in multiple separated databases. → Different organizations have used ISB differently based on local requirements and best practices.
- Because of the unclear practices the data in ISB has decayed over the years.
- Implementation scope of new ERP system (in may 2010) did not include conversion of old ISB to the new ERP system.
- Historically Vaisala has required ISB information mainly to run service operations. Additionally instrument sales has utilized ISB information to clarify market situation

II. Current conditions

- ISB has not been significant support tool for business decisions. In general ISB is not considered as reliable data source.
- ISB information is needed for:
  - 30 000 depot operations per year
  - 500 site visits per year
  - 18 000 tech support cases annually
  - 1000 active service contracts (2011).
- Without ISB information each service activity would require on average excess work of 5 minutes for additional work to gain necessary information / activity. Total work amount 2 man-years* /annually.
- All products delivered though eBS system are automatically stored to ISB, however most of systems delivered through eBS do NOT have proper system structures in place. → Impossible to separate individual products from systems.
  - Vaisala delivers more than 300 systems annually
  - Systems are key drivers for service contract related business
  - Full visibility to the existing system architecture at customer site location is critical for service operations.
- Formal procedures and responsibilities to create and maintain valid ISB, are missing.
- New ERP implementation is on going → significant affect and opportunity to ISB utilization globally.
- Legacy data is NOT available in new ERP system.
- Common understanding of ISB architecture (parameters / attributes) does NOT exist.
- Legacy systems have different architecture in multiple sources depending on the product area.

III. Analysis

- Vaisala ISB has no owner so no one is responsible for the correct creation and maintenance of the ISB.
- Vaisala has long history of being product oriented company. Growth has been based on acquisitions and finding new markets. → ISB not significant driver for business.
- Valid installed Base and effective utilization of the information is one of the most important tools to gain more revenue with current customer base. While doing service business valid ISB information is also needed run operations effectively.
- Reaching new customers is typically more difficult and costly than keeping existing ones. To grow the business, Vaisala needs to maximize the revenue creation through the existing ISB.
- Within 10 years problem related to legacy ISB will be solved automatically, because old data will then be irrelevant. → Estimated additional costs for 10 years operation without legacy ISB is about ~10 man-years (1 MEUR). Added with the lost up-selling business potential (e.g 1% increase of ISB units returning to repair/calibration = 5MEUR / annually).
- Legacy systems and some specific instruments are more valuable to be available through future ISB system than rest of the legacy data. ISB items older than 15 years do not have any significance for service operations or business decisions.
- Functioning ISB system is necessity while transferring to more service oriented business because significant part of service business is generated through existing installed base.

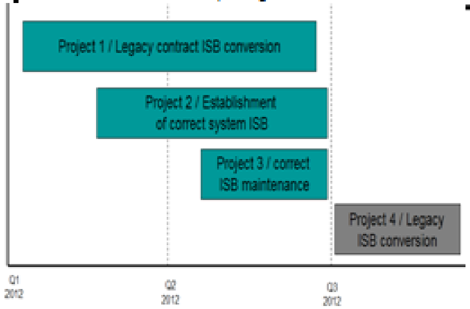
IV. Goals / Targets

Cost savings:
- Fluent handling of service contract related responsibilities.
  - work hour savings 3 man months annually (0,5 hour / contract / year).
- Faster response to technical support queries
  - Work hour savings 1 man-year /annually (10 min/ 10 000 case)
- Lower throughput time for depot repairs
  - Clear item history for decision making
  - Tracable original set up/configuration for disaster recovery
  - 1 man-month annually (100 cases /2h per case)
- Efficient field operations
  - Decreased number of revisits and unplanned site days
  - Work hour savings 2 man-months site visit preperation time (500 visits / 45 min)

Increased business
- Depot capacity increase 100 items / year (20kEUR revenue) (1 man-month additional work time)
- Proactive Sales and Marketing though valid ISB data (5MEUR only for repair/calibration business)
- New ISB based service offering

Improved customer satisfaction
- Faster response time to technical queries (1 day shorter resolution time e.g. one overnight email less)
- Lower system downtime / improved thoughput time
- Service according to contract
- Less revisits costs
- Less explaining/emails needed in order to receive needed support

Total significance 5.2 MEUR



V. Suggested counter measures / plan

- Convert of all active Service Contract related ISB to eBS. (Project 1, started. see separate A3 -1)
- Design of well serving ISB data architecture. (Project 2, started. see separate A3 -2)
- Create guidelines and procedures for proper ISB creation and maintenance. (Project 3, started. see specific A3 -3)
- Implement correct ISB creation and maintanance procedures globally. (Project 2&3, started. see specific A3-2 and A3 -3)
- Search and rescue of all system ISB delivered after year 2000. (Project 4. On hold until summer 2012)
- **Assign ISB owner** (planning - escalated)
- Understand and communicate ISB business impact to Vaisala. (no plan)
- Implement standard practice in Sales/Segment/Marketing to utilize ISB information to grow the business (no plan)

VI. Check / Follow up

- All Active contract related ISB available in EBS by summer 2012.
- Systems are correctly created and maintained in EBS ISB by summer 2012.
- Decision and plan has been made what to do with legacy ISB not covered by service contract.
- Segments / Sales / Marketing have systematic procedures to utilize ISB data.
- Owner has been assigned for ISB.
- Customer satisfaction survey 2012 response time to queries –improvement (partly affected).
- User feedback reports (ISU thesis).

Installed Base (ISB) Maintenance

initials	ISU	TUK	01.2012

I. Background

- For effective service operations and fact based business decisions company requires valid ISB.
- Without clear maintenance procedures, ISB will decay and lose its value. It can even lead us to wrong decisions.
- Unreliable ISB increases Vaisala's costs.

II. Current conditions

- There are no procedures or responsibilities in place for correct ISB maintenance.
- Bad maintenance will lead to situation where:
  - Technical support isn't able to support customers effectively (customer satisfaction and lead times).
  - Field service isn't able to prepare for site visits. ~500 site visits per year. (Risk for re-visits).
  - Depot lead times will increase.

III. Goals / Targets

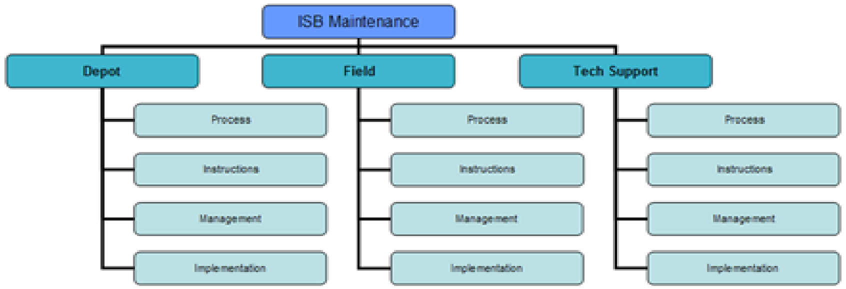
- ISB maintenance procedures are part of standard service processes.
- ISB maintenance instructions are integrated to service process instructions.

IV. Analysis

- No clear understanding how ISB works in eBS system.
- ISB functionality has been falsely assumed to be standard well functioning part of eBS.
- Correct ISB has not been considered business critical.

V. Plan

- Identify all service process steps that include/should include ISB update.
  - Process review and evaluation (40 h)
- Include missing steps and instructions to process documentation.
  - Create instructions (40 h)
  - Upgrade process documentation (20 h)
- Training for applicable service roles. (20 h)
- Define and find acceptance for ISB maintenance responsibilities.



VI. Check

- Make part of internal audit scope.
- User feedback.
- Global comparison.

VII. Issues

- Achieving standard global practice within reasonable time frame.
- Motivating stakeholders for proper maintenance.
- How to prevent arise of competing ISB databases.

Creation of System Installed base (ISB) → Z-Item

initials	ISU	TUK	01.2012

I. Background

- Vaisala delivers 300 systems per year.
- Average life time for Vaisala systems is 10 years, during which it must be supported.
- Almost all project and service related travelling is due to systems.

II. Current conditions

- Most of the systems do not have complete structures in eBS ISB.
- System structures are formed from separate sub-structures, which are not linked to each other.
- There are no procedures or responsibilities in place for correct ISB creation.
- Global requirements concerning establishment of ISB vary based on organization structures.
- Service is not able to link service contracts to correct hardware without significant effort. (2 hours per contract)
- Technical support isn't able to support customers effectively due to lack of system structures. Several thousand cases related to systems per year. (customer satisfaction and lead times)
- Field service isn't able to prepare for site visits. ~500 site visits per year. (Risk for re-visits).

III. Future state

- All systems are delivered to the ISB correctly → system structure and attributes in place.
- Clear responsibilities and procedures including work instructions exist in order to secure consistent ISB creation globally.
- System structure creation is documented part of product creation process.
- Significant cost savings. (see picture)

IV. Analysis

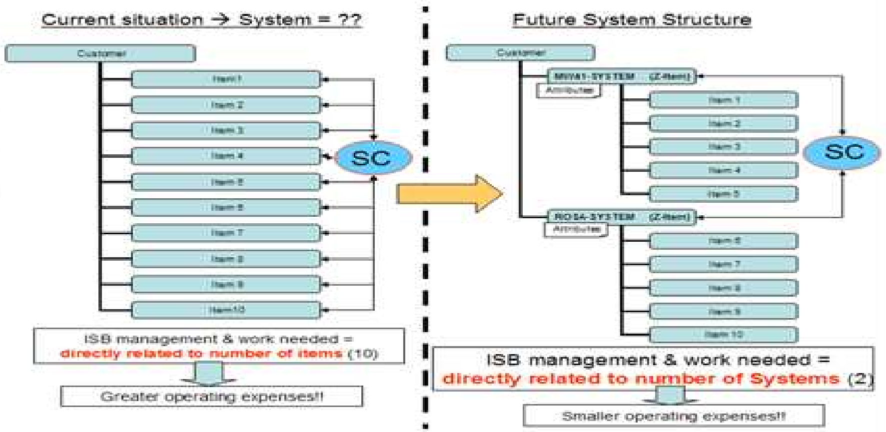
- Most of the Vaisala systems have been productized in a way that top level item is missing from system structure. One of the reasons is that eBS does not allow configurable items inside configurable items.
- Product creation process does not include requirement for top level system structure creation.
- For effective service operations system structures need to be in place.
- For fact based business decisions we need to know how many and what kind of systems we have delivered, and where.

V. Plan

- Creation of work instructions.
- Roles and responsibilities have to be defined.
- Train necessary teams.
- Implement z-item creation in product creation project (LCM).
- Update system delivery processes globally.

VI. Resources required

- Manual system structure creation requires 200 hours annually. (300 systems)
  - Decision to be made which organization(s) are responsible to execute the new tasks.
- Work instructions 40 hours.
- Implementation 40 hours.



VII. Followup

- When MW41 system is launched, system structure is verified.
- Gather user feedback.
- Run sample data from ISB and compare it to sales data. (PR4)